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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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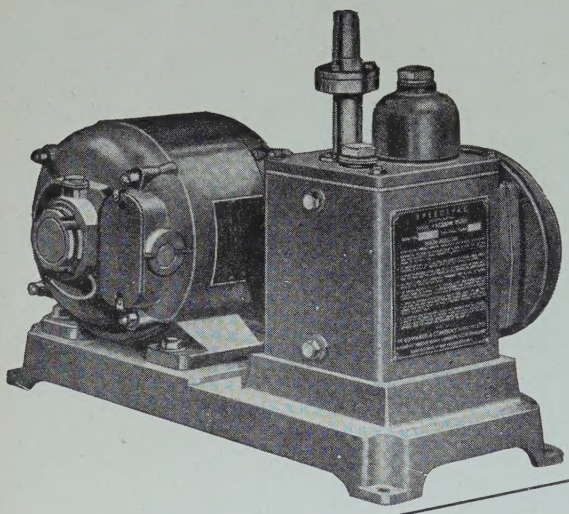
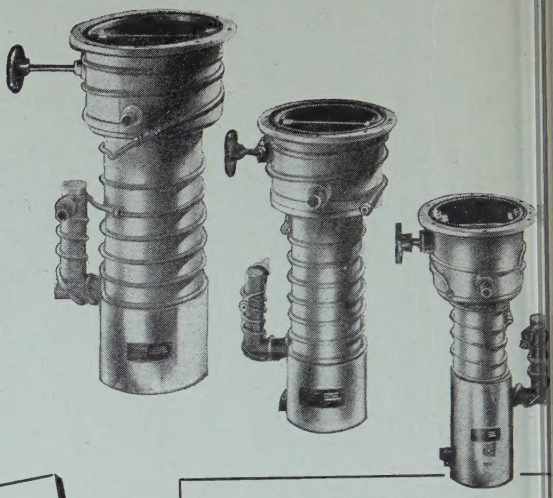
VOLUME 57 **MARCH 1954** NUMBER 675





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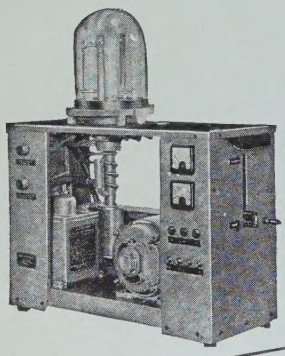

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplement published with the Index to Volume 56 (1953). Reprints of the List of Journals (1953) and the Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Ann. Tokyo Astron. Obs.	*Annals of the Tokyo Astronomical Observatory.* University of Tokyo, Mitaka, Tokyo.
Mém. Sci. phys.	*Mémorial des Sciences Physiques.* Gauthier-Villars, Quai des Grands-Augustins 55, Paris, 6e.
Radio tech. Digest	*Radio Technical Digest.* 122 Boulevard Murat, Paris, 16e.
S.B. Gesell. Beförd. Naturwiss. Marburg	*Sitzungsberichte der Gesellschaft zur Beförderung der gesamten Naturwissenschaften zu Marburg.* N.G.Elwertsche Verlagsbuchhandlung, Marburg.
Sci. Rep. Yokohama Nat. Univ.	*Science Reports of the Yokohama National University.* Section I: Mathematics, Physics. Faculty of Liberal Arts and Education, Yokohama National University, Kamakura, Japan.

New Journal

Brit. Weld. J.	*British Welding Journal.* Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1; British Welding Research Association, 29 Park Crescent, London, W.1. Volume 1, Number 1, dated *January*, 1954. Subscription £5 0s. 0d., single copies 10s. 0d. each. Incorporates the *Transactions* of the Institute and *Welding Research.*

Notes

Akustische Beihefte	Pagination of 1953 issues is that of Volume 3, 1953, of *Acustica.*
Instruments and Automation	Addition to title, and change of address to: 845 Ridge Avenue, Pittsburgh 12, Pennsylvania, commencing *January*, 1954.
Tele-Tech and Electronic Industries	Addition to title, commencing *January*, 1954.

Errata

Subject Index (1953), p. 1285, column 1: **Chemical analysis, radioactive.** Third entry from bottom ("U and Th det. from ores"), abstract number should read 5187.

Abstr. 600 (1954) line 2: *for* W. G. NIELSEN *read* W. G. NILSEN.

Abstr. 808 (1954) line 3: *insert* J. J. BENBOW *as author.*

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 7904 (1952): **32,** *No.* 4, 310 (1953).
Abstr. 5379 (1953): **32,** 696 (*Dec.*, 1953).
Abstr. 6248 (1953): *No.* 24, 628 (1953).
Abstr. 6424 (1953): **33,** *No.* 1, 78 (1953).
Abstr. 8034 (1953): **21,** 2239 (*Dec.*, 1953).
Abstr. 8041 (1953): **21,** 2242 (*Dec.*, 1953).
Abstr. 8363 (1953): **22,** 150 (*Jan.*, 1954).
Abstr. 8626 (1953): **22,** 151 (*Jan.*, 1954).
Abstr. 146 (1954): **24,** 1529 (*Dec.*, 1953).
Abstr. 213 (1954): **32,** 696 (*Dec.*, 1953).
Abstr. 600 (1954): **21,** 2232 (*Dec.*, 1953).
Abstr. 1203 (1954): **25,** 126 (*Jan.*, 1954).
Abstr. 1240 (1954): **25,** 136 (*Jan.*, 1954).
Abstr. 1547 (1954): **10,** 1357 (*Sept.*, 1953).

MATHEMATICS 51

517.52

1942. On the summation of infinite series in closed form. A. D. WHEELON. *J. appl. Phys.*, **25**, 113–19 (*Jan.*, 1954).

A direct approach to the problem of summing infinite series in closed form is described. This method is based on the parametric representation of the general terms of a series, so as to produce either the geometric or exponential series inside one or more integral signs. Each of these may be summed in closed form, thereby permitting one to exhibit a given series as a combination of definite integrals. When the original series is summable, these integrations can be performed analytically and the sum presented in closed form. Such a procedure enjoys the evident advantage of exploiting the relative abundance of integral tables, while circumventing the need for extensive preparation in the field of infinite series. The relations of this development to other methods are indicated and a number of illustrative examples presented. A.

518.3 : 535.3

1943. Nomograms for optical calculation and manufacture. H. JENSEN. *Optik*, **10**, *No.* 10, 462–4 (1953) *In German.*

Nomograms are little used in optics, unlike electronics where they are very common. A number of possible applications are discussed. R. W. FISH

518.5 : 621.372.5

1944. Differentiation and integration quadripoles: deformation. J. GARCÍA SANTESMASES AND J. MAÑAS DÍAZ. *An. Real. Soc. Españ. Fís. Quim.*, **48**(A), 349–54 (*Nov.–Dec.*, 1952) *In Spanish.*

A theoretical and experimental study is made of the deformations produced on using R–C differentiating and integrating quadripoles [Abstr. 2283 B (1950); *An. Real. Soc. Españ. Fís. Quim.*, **45**(A), 329 (*July–Aug.*, 1949)]. It is concluded that with such simple circuits these operations can be carried out with deformations below 4%. A.

518.5 : 621.3.012.8 : 621.372.5

1945. An improved experimental iteration method for use with resistance-network analogues. G. LIEBMANN AND R. BAILEY. *Brit. J. appl. Phys.*, **5**, 32–5 (*Jan.*, 1954).

When solving the wave equation $\nabla^2 U + k^2 U = 0$, and similar field problems, on resistance-network analogues by iteration, an error signal can be derived which is a measure of how far the analogue solution satisfies the given equation. An experimental apparatus is described for displaying simultaneously, on a c.r.t. screen, the error signals ε for a number of resistance-network points; the solution then proceeds until all $\varepsilon \simeq 0$. The apparatus can also be used to display network voltages or gradients, which is helpful in many other kinds of problems solved with resistance-network analogues, and to obtain solutions of "best fit" in equation solvers. A.

518.5 : 681.142 : 621.317.79 : 621.374.32

1946. Analogue vs. digital computers—a comparison. M. RUBINOFF. *Proc. Inst. Radio Engrs*, **41**, 1254–62 (*Oct.*, 1953).

The problem of simulation in real time is used as a basis for comparing the characteristics of the two kinds of machines as regards basic units, size, speed, precision, accuracy, stability, input-output, flexibility and future possibilities. The mathematical operations discussed include addition, subtraction, multiplication, division, evaluation of polynomials and other functions, square root extraction and the solution of ordinary differential equations. A.

518.5 : 681.142 : 621.374.32

1947. Fundamentals of digital computer programming. W. H. THOMAS. *Proc. Inst. Radio Engrs*, **41**, 1245–9 (*Oct.*, 1953).

A simplified stored-programme digital computer is described to show the fundamentals of computer programming. Using 8 instructions a number of basic techniques are illustrated by means of programmes which perform elementary arithmetic and logical computations. The stored-programme computer's capacity for modifying its own programme is demonstrated. A.

518.5 : 681.142 : 621.374.32

1948. The arithmetic element of the IBM Type 701 Computer. H. D. ROSS, JR. *Proc. Inst. Radio Engrs*, **41**, 1287–94 (*Oct.*, 1953).

The arithmetic element of the IBM Type 701 Computer contains a number of innovations, both in circuits and in logic, which distinguish it from that used in other high-speed, parallel, binary computers. The most significant is the storage element used in the arithmetic registers, in place of the more usual flip-flop or trigger circuit. This new element simplifies the methods of executing instructions. A.

518.5 : 681.142 : 621.374.32

1949. The SWAC—design features and operating experience. H. D. HUSKEY, R. THORENSEN, B. F. AMBROSIO AND E. C. YOWELL. *Proc. Inst. Radio Engrs*, **41**, 1294–9 (*Oct.*, 1953).

The SWAC is an ultra-high-speed digital computer utilizing a Williams tube memory, an auxiliary magnetic drum memory and a punched card input-output system. A general description of the functional organization of the computer is given together with a brief discussion of the various commands and how they are executed. Some of the special engineering features of the computer are described, in particular those relating to the electrostatic and magnetic drum memories. A short survey of the types of problems solved during the past year is presented. A.

518.5 : 681.142 : 621.374.32

1950. SEAC. S. GREENWALD, R. C. HAUETER AND S. N. ALEXANDER. *Proc. Inst. Radio Engrs*, **41**, 1300–13 (*Oct.*, 1953).

A comprehensive description of SEAC which

features a novel type of "transformer-coupled dynamic circuitry" and makes extensive use of germanium diodes. SEAC is a synchronous machine, operating at a 1 Mc/s repetition rate. It is essentially serial in operation, employs both acoustic and electrostatic memories, and operates in either the 3- or 4-address mode at the programmer's discretion. This description covers the specifications of the machine, its logical, electrical and physical structure, and finally, its performance over the last three years. A.

518.5 : 681.142 : 621.374.32

1951. The design of the Bendix digital differential analyzer. M. PALEVSKY. *Proc. Inst. Radio Engrs*, **41,** 1352–6 (*Oct.*, 1953).

The error reduction scheme employed by the Bendix analyser, which utilizes both ternary intercommunication between integrators and trapezoidal integration, is described. A device for the variation and automatic resetting of initial conditions is discussed together with an example illustrating its operation. Reduction in size of the computer is considered. A.

518.5 : 681.142 : 621.374.32

1952. A survey of digital computer memory systems. J. P. ECKERT, JR. *Proc. Inst. Radio Engrs*, **41,** 1393–406 (*Oct.*, 1953).

Discusses only the various systems whose reaction time is faster than human reaction time, employing a historical approach. Criteria for evaluation are discussed, and general applicability, ease of construction and use, speed of operation, latency time, memory span and economy are compared. A.

518.5 : 681.142 : 621.374.32

1953. The logical principles of a new kind of binary counter. W. H. WARE. *Proc. Inst. Radio Engrs*, **41,** 1429–36 (*Oct.*, 1953).

In a shifting register or binary counter, there is a real logical requirement for a short term or temporary storage facility. In the counter, this occurs during the interval in which the actual count process is occurring. A positive memory counter is described in which this auxiliary storage is provided by elements which have the same time-indefinite storage property as the principal storage elements of the counter. This leads to a device which has two ranks of storage elements: the "true" and the "false" rank. The behaviour of the single-stage and multiple-stage counter of this kind is derived, and the rules of formation for all numbers appearing in the true and in the false ranks are derived. The basic device is then generalized to one with four modes of operation, and the behaviour and rules of number formation are discussed. An example of the application of the extended counter to a computing machine is given. A.

518.5 : 681.142 : 621.374.32

1954. Coded decimal number systems for digital computers. G. S. WHITE. *Proc. Inst. Radio Engrs*, **41,** 1450–2 (*Oct.*, 1953).

From the very large numbers of possible ways of coding the 10 decimal digits into sets of binary elements, a restricted group of number systems is presented as being particularly adaptable for representing the decimal digits in digital computers. As an example, one number system of this group is presented which permits the construction of a very simple addition circuit. A.

518.5 : 681.142 : 621.374.32

1955. Serial digital adders for a variable radix of notation. R. TOWNSEND. *Electronic Engng*, **25,** 410–16 (*Oct.*, 1953).

A description is given of four different methods of adding numbers, in a digital computer, which are represented in serial coded groups, the digit within each group being in a serial binary code. Each group can portray a number with a different radix of notation, so that quantities having a variable radix such as sterling, tons, hundredweights and quarters, etc., can be represented. The radix of notation of the groups may be changed at will during the course of a programme. A.

519.2 : 53

On statistical estimation in physics. *See Abstr.* 1991

519.3 : 53 : 61

1956. Calculus of variations with applications to physics and engineering. R. WEINSTOCK. *London: McGraw-Hill* (1952) x + 326 *pp.*

Review in *Proc. Phys. Soc.* [*London*] *A*, **66,** 855 (*Sept.*, 1953). "Deals with both the mathematical theory of the calculus of variations and its application to a selection of problems in physics. These include examples on the dynamics of particles, electrostatics and geometric optics, but the main emphasis is on eigenvalue problems for which the associated differential equation is of the Sturm–Liouville type."

519.4

1957. On a theorem for the reduction of some representations of the symmetric group. A. GAMBA AND L. A. RADICATI. *R.C. Accad. Naz. Lincei*, **14,** 632–4 (*May*, 1953) *In Italian.*

The theorem relates to certain Young tableaux which are useful in the problem of reducing the product of two irreducible representations of the symmetric group. The problem itself occurs in an application of group theory to nuclear physics [Abstr. 7539 (1952)]. L. S. GODDARD

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.11

1958. Observations on the problem of two bodies of variable mass and some applications to cosmogony. G. ARMELLINI. *R.C. Accad. Naz. Lincei*, **14,** 727–33 (*June*, 1953) *In Italian.*

In view of recent suggestions that stellar masses may be reduced by considerable fractions in the course of evolution on account of continuous corpuscular emission, the author recapitulates his theory of binary systems with decreasing mass. The theory predicts that the mean distance of the components and the eccentricity of the orbit will increase with time. R. A. NEWING

522.56

1959. On the influence of protecting spherical glass domes of Moll thermopiles used for solar measurements. M. T. ANTUNES. *Bol. Soc. Portuguesa Cienc. Nat.*, **4**, *Pt II*, 163–97 (1952) *In French.*

From a quantitative treatment of possible disturbances due to various shapes and arrangements of such protective glass covers it is concluded that these can account for a few per cent only in the observational discrepancies, and cannot be made responsible for the large deviations of up to 50% in the standardization measurements involving the sun's altitude; for these certain internal conditions of the thermopile are suggested as an explanation. A. BEER

522.6 : 523.165

1960. Radioastronomy. I. Method of observation. W. DIEMINGER. *Arch. elekt. Übertragung*, **7**, 421–8 (*Sept.*, 1953) *In German.*

Short survey of current techniques used for radio-astronomical studies. W. J. G. BEYNON

522.6 : 523.165 : 621.396.9

1961. New techniques in radio astronomy. J. D. KRAUS AND E. KSIAZEK. *Electronics*, **26**, 148–52 (*Sept.*, 1953).

The radiations from outer space are described. A radio telescope has been built for use at 250 Mc/s. The aerial is a double row of 24 helical elements spaced on a 160 ft reflecting sheet. This has beam widths of 1·2° right ascension and 17° declination. The two halves of the array can be switched so as to give "split lobe" or "difference" aerial patterns. The input of the receiver is switched from the aerial to a matching resistor at 30 c/s and the output is fed to a phase-sensitive receiver and a pen recorder.

W. T. BLACKBAND

522.612

1962. The solar magnetograph. H. W. BABCOCK. *Astrophys. J.*, **118**, 387–96 (*Nov.*, 1953).

A new instrument for measuring and recording weak magnetic fields on the surface of the sun has been developed for use with the 150 ft solar telescope and 75 ft spectrograph of the Hale Solar Laboratory. Principal features include: a superior grating of high resolving power for use in the fifth-order spectrum; an electro-optic analyser for polarization; a double-slit detector for the longitudinal Zeeman effect; and a self-synchronous system by which the disk of the sun is scanned in a raster of parallel traces, the results as to magnetic intensity and polarity being presented conformally on the screen of a cathode-ray tube and recorded by a camera. The noise level (about 0·1 G) is such that fields of the order of 1 G can be recorded readily. The method of calibration is described, and the possibility is pointed out of using the instrument, with a slight optical modification, for studying small Doppler shifts in the sun's atmosphere. A.

523.1

1963. A new approach to cosmology. IV. A. E. H. BLEKSLEY. *S. African J. Sci.*, **50**, 61–4 (*Oct.*, 1953).

In Pt III [Abstr. 8442 (1951)] it was shown that owing to the variation of the constant of gravitation with the age of the universe, there are two definable time-scales in physics, namely, atomic time and dynamical time. In this paper some of the consequences of this result are investigated. It is shown that all dynamical timekeepers possess periods which are invariant in dynamical time, thus justifying the terminology. A relation is derived between the length of a given interval as measured in the atomic system and that given in the dynamical system, which leads to the conclusion that the present dynamical age of the universe is twice its atomic age. Expressions are found for the velocity and the acceleration of a moving body as measured in the two time scales, and for the variation in dynamical time of certain atomic constants which have been found invariant in atomic time. In dynamical time, as would have been expected, the constant of gravitation is invariant. It is shown that the length of the day, defined by the rotation of the earth, is increasing at the present time as measured by an atomic clock. A.

523.112

1964. A query concerning the steady-state theory of the homogeneous expanding universe. G. J. WHITROW. Letter in *Observatory*, **73**, 205–6 (*Oct.*, 1953).

Attention is drawn to an apparent paradox arising from the fact that an event occurring at the world-horizon of one fundamental observer will not in general occur at the world-horizon of a second fundamental observer. R. A. NEWING

523.12

1965. Progress in the problem of the origin of stars. P. JORDAN. *Naturwissenschaften*, **40**, *No.* 21, 541–5 (1953) *In German.*

A review of current theories. R. A. NEWING

523.162.1

1966. Interstellar polarization and magnetic fields. G. R. BURBIDGE. Note in *Astrophys. J.*, **118**, 575–7 (*Nov.*, 1953).

The Davis–Greenstein theory (1951) of polarization by partially aligned dust grains is examined in relation to the existence of galactic fields as weak as 7×10^{-6} gauss. If the field is perpendicular to the beam of light, the grain size required by the theory agrees with previous estimates. R. A. NEWING

523.165

1967. A radio model of the Galaxy. S. P. WYATT, JR. *Astrophys. J.*, **118**, 304–13 (*Sept.*, 1953).

An analysis is carried out to determine the structure of the Galaxy as it is defined by the intensity distribution of continuous radio emission at 100 Mc/s. Observational data are the radio isophotes of Bolton and Westfold. Results depend on the likely assumptions that the radio Galaxy is axially symmetric and that it is transparent at 100 Mc/s. The density function in the galactic plane turns out to be approximately Gaussian in character, with a fairly "flat" nucleus, the sharpest decay in the regions of 2–4 kiloparsecs from the centre, and a nearly linear decrease in the vicinity of the sun. The curve agrees with that found by Bolton and Westfold for the inner part of the Galaxy. The density of radio sources in the galactic core is $5\cdot4 \pm 1\cdot2$ (p.e.) times the local density near the sun; and the average emission in our part of the Milky Way system is $1\cdot1\times10^{-39}$ ergs cm^{-3} sec^{-1} (cycles/sec)$^{-1}$. Superposed on the smooth radio Galaxy are two additional features: first, a constant component with brightness temperature

about 450°K, to be identified with the spherically distributed excess radiation discovered by Westerhout and Oort; second, an asymmetric component in the anticentre directions, probably originating from H II clouds in the Morgan–Osterbrock–Sharpless spiral arm that passes about 300 parsecs exterior to the sun. The density distribution in the z-direction is assumed to follow a Gaussian law. From this approximation, it is found that in the nuclear part of the Galaxy the precision modulus of the distribution at right angles to the galactic plane is five times its value in the plane. In the solar neighbourhood the ratio is only about 3. A.

523.4

1968. Internal structure of the giant planets. A. DAUVILLIER. *C.R. Acad. Sci.* [*Paris*] **237**, 951–3 (*Oct.* 28, 1953) *In French.*

It is shown that the hypothesis of an atmosphere rich in H has up to now hindered an understanding of the nature of the giant planets. A model, based on data from cosmical abundance tables of the elements and their compounds, which contains little free H or He is described. The loss of these gases by the giant planets is explained by inference from the kinetic theory. D. R. BARBER

523.5

1969. The physical theory of meteors. IV. Inquiry into the radiation problem—a laboratory model. R. N. THOMAS AND W. C. WHITE. *Astrophys. J.*, **118**, 555–67 (*Nov.*, 1953).

For Pt III, see Abstr. 2148 (1953). The similarity in atomic spectrum between meteor and artificial meteor (ultra-speed pellet) is discussed. The meteor is equivalent to a mono-energetic atomic beam; the pellet, to a high-temperature furnace in a highly transient and probably non-equilibrium state. The excitation mechanism is probably atom-atom inelastic collision in both cases. A consideration of the pellet molecular spectrum strengthens these conclusions. The pellet molecular spectrum appears to provide information on diffusion processes in the wake. Present spectrophotometric data on both meteor and pellet are very incomplete. A.

523.53

1970. Verification, with the help of radar, of the altitude of disappearance of meteor trails from a known radiant. P. VOLMER. *C.R. Acad. Sci.* [*Paris*] **237**, 1065–7 (*Nov.* 2, 1953) *In French.*

The ranges of the shortest-range echoes from a meteor shower (Perseid) are plotted against the hour angle of the radiant, and compared with the theoretical minimum ranges computed for various heights of disappearance of ionization. A mean height of about 85 km for meteors incident normally is indicated; the observations also show an increase in the height of disappearance with increasing zenith-distance of the radiant. M. W. OVENDEN

523.72

1971. On one possible mechanism for sporadic radio radiation from the sun. G. G. GETMANTSEV AND V. L. GINZBURG. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 2, 187–90 (1952) *In Russian.*

An analysis is given of the hypothesis that these bursts of intense radiation are caused by relativistic electrons or protons in the magnetic field of a sunspot. Calculations of the number of electrons to produce the observed effect are given and lead to values of about 100 per cm^3. J. M. HOUGH

523.74

1972. The magnetic field strength in sunspots. W. MATTIG. Note in *Naturwissenschaften*, **40**, *No.* 20, 523 (1953) *In German.*

Discussion of Thiessen's criticisms [Abstr. 5838 (1953)] of the author's expression for the variation of the magnetic field strength within sunspots [Abstr. 5837 (1953)]. The validity of the author's measurements and their representation (and the superiority over Broxon's previous attempt) is maintained, although the possibility of small corrections is not excluded. A. BEER

523.75

1973. The temperature of prominences. P. TEN BRUGGENCATE. *Nachr. Akad. Wiss. Göttingen, math.-phys. Kl. IIa*, *No.* 13, 121–38 (1952) *In German.*

A detailed description is given of the technique used for photographic spectrophotometry of solar prominences with the Göttingen tower telescope and grating spectrograph [Abstr. 4857 (1952)]. From corrected curves of growth for H_α and H_β an observed prominence temperature of 3700°K is obtained, agreeing with the Boltzmann temperature computed for the observational material, taking the 2, 3 and 4 quantized states of H. From line-widths of He(D_3) and H_β, a kinetic temperature of 13 000°K is found. The free electron density in the prominence material is $\sim 10^{10}$/cm^3. D. R. BARBER

523.75

1974. Solar flares and associated 200 Mc/sec radiation. H. W. DODSON, E. R. HEDEMAN AND L. OWREN. *Astrophys. J.*, **118**, 169–96 (*Sept.*, 1953).

Study of 200 Mc/s solar radiation for the times of 194 flares indicates distinctive radio events associated with 78% of the flares. The flare-associated distinctive events can be divided into ten descriptive types or categories: major burst, major burst with second part, minor burst, minor burst with second part, micro burst, group of bursts, series of bursts, noise storm in progress, onset of noise storm, and rise in base level. In addition, there is the designation "null," or no distinctive event. Consideration of the time relationships between flares and 200 Mc/s events suggests that two quite different types of phenomena may be represented in the flare-associated 200 Mc/s radiation. The first or "early" phenomenon includes very sudden, relatively isolated, burstlike features which occur close to the time of start of the flare. The second or "late" phenomenon includes the more gradual rises in base level and onsets of noise storms. These usually start at or after the time of flare maximum. The "early" and "late" phenomena can occur in conjunction with each other, or either of the two can occur separately. The importance of the flare, position on the solar disk, and accompanying ionospheric disturbances are considered with respect to the form and energy excess of the flare-associated 200 Mc/s events. The various aspects of the complex flare phenomenon, as observed photographically and visually, are discussed. An association is suggested

between the high-velocity ejections observed at the onset of certain flares and the occurrence of a major burst at 200 Mc/s. From the point of view of the parameters considered in this paper, the flares for which there were no distinctive events on the 200 Mc/s records constitute a random sample from the entire set of 194 flares. A.

523.75

1975. Isophotal photometry of a solar flare. D. E. Billings and W. O. Roberts. *Astrophys. J.*, **118**, 429–35 (*Nov.*, 1953).

Gives isophotal contour maps of the solar flare of April 12, 1950, at various stages of development, and a plot of integrated intensity of the flare as a function of time. Measurements indicate that at flare maximum the earth received a radiation of solar H_α energy/sec which exceeded "quiet"-sun H_α radiation by nearly 2×10^{18} ergs/sec. The estimated total energy in H_α reaching the earth from the sun between the recognized start of the flare and its end exceeded that from the quiet sun for a corresponding time interval by approximately 9×10^{21} ergs. A.

523.75

1976. A study of the motions of solar prominences. L. Larmore. *Astrophys. J.*, **118**, 436–52 (*Nov.*, 1953).

The motions of knots of four prominences were studied from Climax films. Measurements were taken by means of a polar grid superimposed on photographic prints of each frame. The four prominences include active, eruptive, sunspot and active-eruptive types. There are no cases of sudden velocity increase, as found by Pettit. The good detail shown by the Climax films points to a twofold explanation of the supposed first law of prominence motion. It is attributed to (1) approximations involved in curve-fitting, and (2) overtaking or ambiguity of identification of the knots and streamers. A parabola approximates the time-distance diagrams to a high degree of accuracy. On this basis, average accelerations are determined graphically for 85 knots and listed for both radial and angular components. The trajectories follow closely those computed by Evans on the basis of an electromagnetic field. The force fields for knots travelling similar trajectories are found to be nearly constant with time as long as the form of the prominence is constant, but the forces apparently change when the form changes. A theory of an eruptive mechanism for prominences is suggested. A.

523.774

1977. Carbon monoxide in the sun. L. Goldberg and E. A. Müller. *Astrophys. J.*, **118**, 397–411 (*Nov.*, 1953).

Nearly 300 lines of carbon monoxide have been identified in the spectrum of the solar limb between 2·29 and 2·50 μ. The lines belong to the overtone bands 2–0, 3–1, 4–2, 5–3, 6–4 and 7–5. Analysis of the solar wavelengths has led to a new determination of the vibrational and rotational constants of the CO molecule. The measured absorption coefficients of Penner and Weber and the theoretical values of Scholz have been applied to the measured equivalent widths at the centre of the disk. The resulting equivalent abundance of CO is $1\cdot45\times10^{19}$ molecules per cm^2 above the photosphere, and the excitation temperature is 4300°K. It is shown from model-atmosphere calculations that solar CO is concentrated near the top of the photosphere and hence that the derived excitation temperature is consistent, since it agrees with the boundary temperature. At present it is not known whether the dissociation energy of CO is 9·6 or 11·1 eV. If the lower value is correct, the solar-line intensities suggest that the boundary temperature is less than 4500°K. The exact value of the temperature depends on the choice of atomic abundances for O and C. The low intensities of the fundamental band lines of CO in the 4·6 μ region are explained as a consequence of (1) the high opacity of the solar atmosphere at long wavelengths, (2) the importance of stimulated emissions in the infrared, and (3) the small collisional line widths in the sun's outer layers. A.

523.8

1978. The physical and spatial characteristics of stars with $V \geqslant 40$ km/sec. The longitude effect for a group of high-velocity stars. M. C. Ballario. *Mem. Soc. Astron. Ital.*, **24**, *No.* 3, 275–304 (1953) *In Italian, with summary in English.*

Physical and space characteristics of stars of apparent magnitude $\leqslant5\cdot5$, with peculiar velocities $\geqslant40$ km/sec have been investigated. Two preferential zones are found for the apices of these stars, viz., Zone K_1, between galactic long. 135° and 210°, and lat. +35° to −40°; and Zone K_2, between long. 288° and 349°, and lat. +20° to −30°. Zone K_1 stars exhibit an almost uniform distribution within the zone, with complete absence of B-type stars. There is a tendency for stars with greatest longitude to show a high mean velocity. The stars of zone K_2 do not show the usual galactic crowding, and again B-stars are statistically absent. A relative abundance of K-type stars is found. A strong dependence on longitude is found for this zone, the mean velocity increasing with a decrease of longitude.

D. R. BARBER

523.85

1979. On the fragmentation of gas clouds into galaxies and stars. F. Hoyle. *Astrophys. J.*, **118**, 513–28 (*Nov.*, 1953).

Seeks to trace the steps whereby an extensive cloud of density 10^{-27} g/cm^3 evolves, first into galaxies and then into stars. The indication is that galaxies are likely to form, not as single objects, but in clusters. Stars apparently form at an early stage in the history of a galaxy. There would seem to be reason why the average mass of such stars should lie somewhat below the solar mass. A.

523.85

1980. On a galactic model. A. Dauvillier. *C.R. Acad. Sci.* [*Paris*] **237**, 1298–300 (*Nov.* 23, 1953) *In French.*

A speculative discussion in which matter and stars ejected from a rotating galaxy are assumed to condense to form globular clusters which ultimately return to the galactic nucleus thus setting up a circulation of matter within the galaxy. R. A. NEWING

523.852

1981. Thermal effects of collisional line excitation in gaseous nebulae. L. H. ALLER. *Astrophys. J.*, **118,** 547–54 (*Nov.*, 1953).

The cooling effects of ions of oxygen, neon, nitrogen and other light elements may be estimated from the observed intensities of all the relevant forbidden lines. The electron temperatures in nebulae such as IC 418, with relatively weak forbidden lines (as compared with the Balmer lines), must be substantially greater than in nebulae with relatively strong forbidden lines. Thus the electron temperatures in high-excitation planetaries are not necessarily higher than those in low-excitation planetaries but may even be relatively low. The electron temperature cannot rise substantially above 25 000° or 30 000°K in a planetary nebula because of the dissipation of energy in the excitation of the hydrogen lines, unless the hydrogen is substantially all ionized. A.

523.852.22

1982. A simple model for expanding planetary nebulae and its statistical consequences. H. ZANSTRA. *Observatory*, **73,** 198–200 (*Oct.*, 1953).

The velocity and density at a distance r from the central star are assumed $\propto r$ and $1/r$ respectively. If the luminous part (complete ionization) of a nebula extends to $r = r_n$ and the expansion velocity is then v_e, $dN(r_n)/dr_n \propto r_n^{-\frac{3}{2}}$ and $N(v_e) \propto v_e^{\frac{1}{2}}$, where $N(r_n)$ and $N(v_e)$ are the expected number of nebulae with radii $\leqslant r_n$ and expansion velocities $\leqslant v_e$.

R. A. NEWING

523.874

1983. A statistical study of the rotation of the stars. S.-S. HUANG. *Astrophys. J.*, **118,** 285–303 (*Sept.*, 1953).

The line widths in the spectra of about 1550 stars were measured on Lick plates, and a simple procedure for converting the line width to the rotational velocity is advanced. The results of these measurements are compared with the results by other authors. Some statistical data, such as the frequency distribution, the mean value, etc., which can be derived from the present measurements are also given. The problem of the correlation between the space motion and the rotational motion of the stars is also discussed. A.

523.875

1984. The frequency function of stellar masses. K. FERRARI D'OCCHIEPPO. *S.B. Österr. Akad. Wiss. IIa*, **161,** *No.* 7–8, 175–206 (1952) *In German.*

With the aid of the mass-luminosity law, and a knowledge of the bolometric luminosity function, ρ, for differing stellar types, frequency functions are computed from representative statistical material, and tabulated in order of decreasing bolometric magnitude within the range -6^m95 to $+9^m00$. A proportionality is found to exist between the frequency parameter, ϕ, and the function $M - \beta$, where M is the stellar mass, and β has a value ~ 4. The cosmological significance of the results is briefly discussed. D. R. BARBER

523.877

1985. Pulsations of a rotating star. S.-S. HUANG. *Ann. Astrophys.*, **16,** *No.* 5, 315–20 (1953).

The variational method introduced by Ledoux and Pekeris for studying the pulsation of stars is extended to the case of rotating stars. Also, the relation between the present method and the one used by Cowling and Newing is investigated. A.

523.877

1986. On the convective equilibrium of a star under generalized polytropic conditions. M. CIMINO. *R.C. Accad. Naz. Lincei*, **14,** 779–83 (*June*, 1953) *In Italian.*

Some general equations are derived for equilibrium in which the polytropic index is a function of temperature, particular attention being given to the case $n = n_0 + n_1 T^{m_1}$, where n_0, n_1 and m_1 are constants.

R. A. NEWING

523.877

1987. Inhomogeneous stellar models. III. Models with partially degenerate isothermal cores. M. SCHWARZSCHILD, I. RABINOWITZ AND R. HÄRM. *Astrophys. J.*, **118,** 326–34 (*Sept.*, 1953).

For Pt II, see Abstr. 3833 (1953). A search was made for conditions under which models with partially degenerate isothermal cores could give radii as large as those of red giants. Special conditions were found for which detailed computations gave, indeed, models fitting well the red giants in radius and luminosity. But it has not been investigated whether the special conditions are likely to be realized in the evolution of a star. A.

523.877

1988. The internal structure of red dwarf stars. D. E. OSTERBROCK. *Astrophys. J.*, **118,** 529–46 (*Nov.*, 1953).

Models are computed for red dwarf stars, with the hydrogen convection zone taken into account. The calculations show that in red dwarfs this outer convection zone extends inward for a distance of about 30% of the radius of the star. The central temperatures of these models are found to be much lower than the central temperatures of models computed under the assumption of radiative equilibrium throughout the star. Thus the earlier difficulty of an overproduction of energy by the proton-proton reaction does not appear in these models. The observed luminosities, masses and radii of red dwarf stars such as Castor C and α Cen B can be understood in terms of these models and lead to normal abundances of the elements. For very late-type dwarfs, such as Kr 60 A, other physical effects appear to become important, and the models of the present paper probably are no longer applicable. A.

523.877

1989. Sirius and the carbon cycle. T. L. SWIHART. Note in *Astrophys. J.*, **118,** 577–9 (*Nov.*, 1953).

The effect of low-energy resonance on the $N^{14}(p, \gamma)$ reaction in the carbon cycle will be to reduce the mean life of the reaction below that of the $C^{12}(p, \gamma)$ reaction: the latter will then determine the rate of energy production by the cyclic process. Two Cowling point-source models of Sirius have been examined: (1) with a uniform composition, and (2) with a non-uniform composition, the central molecular weight taken as unity. In both cases it is found that the computed rates of energy production appear compatible with the prescribed requirements, and give reasonable predictions for the composition parameters. Since the first model assumes that the

$C^{12}(p, \gamma)$ reaction has the longer mean life, and the second does not, the results do not eliminate the possibility that the energy production is modified by low-energy resonance. The two models yield lower limits to the age of Sirius of $1{\cdot}7\times10^8$ and $3{\cdot}0\times10^8$ yr respectively. D. R. BARBER

PHYSICS 53

53 : 51

1990. Methods of mathematical physics. I. R. COURANT AND D. HILBERT. *New York and London: Interscience Publishers*, 561 *pp.*

Review in *Phil. Mag.*, **45,** 106 (*Jan.*, 1954). This is a translation (and slight revision) of the well-known German book. It treats such topics as linear integral equations, the calculus of variations, and eigenvalue problems in a manner which is useful to both the mathematician and the physicist.

53 : 519.2

1991. On statistical estimation in physics. M. ANNIS, W. CHESTON AND H. PRIMAKOFF. *Rev. mod. Phys.*, **25,** 818–30 (*Oct.*, 1953).

The problem of the estimation of parameters determined statistically from physical measurements is discussed. Emphasis is placed on the fundamental role played by the prior probability distribution for the parameter. The validity of "maximum likelihood" estimation is examined with particular reference to the case of the estimation of a parameter which actually has a unique but (originally) unknown magnitude. Situations in which the prior probability distribution for the parameter is completely unknown are treated and a method is described for the calculation of this distribution from appropriate experimental data. Many examples are given throughout from the field of cosmic radiation. A.

FUNDAMENTALS 530.1

530.1

1992. The velocities of fundamental particles. L. L. WHYTE. Letter in *Phil. Mag.*, **44,** 1303–4 (*Nov.*, 1953).

The author advocates a re-examination of the concept of velocity when applied to particles lighter than nucleons. Experiments are suggested which do not use stationary conditions, but where static or periodic fields are replaced by separate signals, as in experiments with neutrons and atomic and molecular beams. G. FIELD

530.12

1993. On the field equations of Einstein's unified relativistic theory. B. FINZI. *R.C. Accad. Naz. Lincei*, **14,** 581–8 (*May*, 1953) *In Italian.*

In Einstein's latest theory [*The meaning of relativity*, 4th ed. (1953)] the field equations are derived from a variational principle, the g_{ij} being subject to the restriction $\mathfrak{g}^{ik}$, $k = 0$. Finzi introduces a modified principle from which may be deduced all the field equations including the restriction on g_{ij}.

R. A. NEWING

530.12

1994. Do the Lorentz transformations form a group? V. LALAN. *Ann. Phys.* [*Paris*] **8,** 653–61 (*Sept.–Oct.*, 1953) *In French.*

The 6-parameter group under which $x^2 + y^2 + z^2 - c^2t^2$ is invariant includes purely spatial rotations. "Special" Lorentz transformations are therefore defined as those reducible to the canonical form $x' = \beta(x - Vt)$, $y' = y$, $z' = z$, $t' = \beta(t - Vx/c^2)$, $\beta = (1 - V^2/c^2)^{-\frac{1}{2}}$ by spatial rotations. The 3-parameter family of "special" transformations are shown not to form a group, and this result is discussed in geometrical terms. R. A. NEWING

530.12

1995. Nonsymmetric unified field theories. W. B. BONNOR. Letter in *Phys. Rev.*, **92,** 1067 (*Nov.* 15, 1953).

In Kurşunoğlu's proposed modification of Einstein's non-symmetric unified field theory [Abstr. 2408 (1952)] the assumption is made that mass is entirely electromagnetic in origin. Investigation of the static, spherically symmetric solution seems to show that this assumption is not justified. G. FIELD

530.12 : 531.18

1996. On a kinematic variant of Sagnac's experiment. I–II. M. GALLI. *R.C. Accad. Naz. Lincei*, **14,** 635–41 (*May*); **15,** 58–64 (*July–Aug.*, 1953) *In Italian.*

In Pt I a careful discussion is given of the suggested Prunier–Dufour experiment in which material particles in place of photons are made to travel in opposite directions round a rotating disk. It is concluded that there would be no observational differences between the predictions of classical and relativistic kinematics, apparent differences arising from differences in conventional clock synchronizations. In Pt II the possibility of distinguishing between the two theories by the use of rotating systems is discussed in general terms. It is concluded that such discrimination is unlikely to be achieved, and would in any case be of little value as such investigations would involve dubious extensions of special relativity theory.

R. A. NEWING

530.12 : 538.3

1997. On the electromagnetic potentials in Einstein's unified theory. B. TODESCHINI. *R.C. Accad. Naz. Lincei*, **14,** 495–500 (*April*, 1953) *In Italian.*

The potentials are introduced by the relation $g^{\overline{rs}} = \frac{1}{2}e^{lnsr}(\phi_{n;\,l} - \phi_{l;\,n})$ and the equation corresponding to D'Alembert's equation for wave propagation in free space is derived. R. A. NEWING

530.145

1998. Fields defined by elementary laws. A. RUBINOWICZ. *Acta phys. Polon.*, **11,** *No.* 2, 155–78 (1952).

Supposing that a given scalar field u is isotropic

and homogeneous and corresponds to a linear physical law it is possible to define it by an elementary law (possibly empiric) in the form of a spherically symmetric field of a simple source $u = f(r)$. Its partial fields are namely given by $f(r)$ and the derivatives of $f(r)$ with regard to Cartesian coordinates x, y, z. The fields of the l'-th derivatives may be interpreted as fields of multiple sources of order $2^{l'}$. By a linear superposition of such fields it is possible to obtain multipole fields $Y_{l,m}(\theta, \phi)R_l^{l'}(r)$ of order 2^l (where $l' = 1, 1+2, 1+4 \ldots$) given by simple formulae and having generally singularities in the source point $r = 0$. To obtain functions of the form $Y_{l,m}(\theta, \phi)S_l^{l'}(r)$ which are finite at $r = 0$, the field of the simple source $u = f(r)$ may be developed into a series containing the functions $R_l^{l'}(r)$. In the field given by a superposition of all these fields $Y_{l,m}(\theta, \phi)R_l^{l'}(r)$ and $Y_{l,m}(\theta, \phi)S_l^{l'}(r)$ it is possible to formulate boundary value problems for a sphere, if the number of linearly independent functions $R_l^{l'}(r)$ and $S_l^{l'}(r)$ with a given l is finite. The question then arises under which suppositions it is possible to formulate boundary value (and in certain cases also eigenvalue) problems for domains of an arbitrary shape for such a field given by an elementary law only. The formulae expressing the multipole fields $Y_{l,m}(\theta, \phi)R_l^{l'}(r)$ by the fields of multiple sources can be applied also to write down immediately all the multipole solutions and in certain cases also all the solutions regular at $r = 0$ of any differential equation of the form $\sum_{s=0}^{n} a_s \Delta^s u = 0$ (especially the potential or the wave equation). The solutions which are regular at $r = 0$ are obtainable in any case also in another way. It is further possible to use the above formulae to replace in Green's formula a simple source by arbitrary multipole sources using simple derivations only. All formulae apply also to time-dependent fields, for example in the case of the wave equation. In an appendix the question is discussed how far a given field determines its source system. A.

530.145

1999. A divergent series in intermediate representation. A. PETERMANN. *Helv. phys. Acta*, **26**, *No.* 7–8, 731–42 (1953) *In French.*

Using Dyson's intermediate representation which was successfully applied to the Φ^3 field theory in order to remove series-divergencies, it is shown that, for a given normal product, the irreducible graphs of a Φ^4 theory lead to a still divergent series. A.

530.145

2000. The conservation quantities of classical field mechanics. L. WALDMANN. *Z. Naturforsch.*, **8a**, 417–28 (*July*, 1953) *In German.*

The quantities satisfying conservation laws in the Bopp–Feynman field mechanics [H. Hönl, *Ergebnisse der exakten Naturwissenschaften*, **26**, 291 (1952)] are represented by integrals along the world line. The results are applied to motion in a circle and are considered in detail, using a rectangular structure function. W. A. HEPNER

530.145

2001. On non-local quantum electrodynamics. J. RAYSKI. *Acta phys. Polon.*, **11**, *No.* 2, 109–30 (1952).

A general rule for constructing observable densities enables the formulation of a non-local electrodynamics. The basic equations describing the interaction between the electromagnetic and the electronic fields are integral (or mixed integro-differential) equations. The free waves and the non-local analogues of Green's functions Δ^{ret}, Δ^{adv} may be constructed by invoking Born's principle of reciprocity (i.e. a symmetry between position and infinitesimal displacement operators). The S-matrix may be constructed by Yang's method. The commutation relations for the (perturbed) fields may be computed from the field equations, provided the homogeneous integral equations possess no solution. The conservation laws are secured in spite of the absence of continuity equations. Constant electromagnetic potentials are shown to be physically meaningless. The non-local formalism is free from the usual convergence difficulties. A.

530.145

2002. New formulation of one-body problem in quantum electrodynamics. M. NAMIKI AND Y. SUZUKI. *Progr. theor. Phys.*, **9**, 223–37 (*March*, 1953).

One-electron states at time t are reasonably defined and the space spanned by them is denoted by $\mathfrak{H}_1^e(t)$. The one-electron problem is clearly formulated using $\mathfrak{H}_1^e$. The motion of the projection of a given state Ψ on to $\mathfrak{H}_1^e$ is described by the "wave function." If Ψ is in $\mathfrak{H}_1^e(-\infty)$ the "wave function" satisfies the equation given by Schwinger. The probability of staying in the one-electron state and the expectation values of physical quantities are written as the generalized form of ordinary quantum mechanics so as to indicate the non-local character of the theory. The expectation value of energy has the imaginary part concerned with the damping property. The theory is applied to the problem of Lamb shift and line breadth. Divergence difficulties are not concerned. A.

530.145

2003. On the transition amplitude in quantum electrodynamics. S. HORI. *Progr. theor. Phys.*, **9**, 299–311 (*March*, 1953).

A set of orthonormal states is constructed by operating (free) photon-, electron- and positron-creation operators one after another to the (free) vacuum state Ψ_0. Any state, say $\Psi[\sigma]$, can be expanded in terms of these orthonormal states. An equation is derived in a covariant form which is satisfied by a coefficient of the expansion which is a functional of σ and whose absolute square may be interpreted as the transition probability. The procedure may be regarded as the transition to the Fock space. In the last section, relation to the S-matrix is also discussed. A.

530.145

2004. On the diagonalization of the Hamiltonian in field theory. II. B. FERRETTI. *Nuovo Cimento*, **10**, 1079–125 (*Aug.*, 1953) *In Italian.*

For Pt I, see Abstr. 4091 (1951). A renormalization method for quantum electrodynamics which in no step makes use of the perturbation theory, is carried on by using some ideas proposed in Pt I. In this method the electric charge is a parameter which may vary with continuity. It is then shown how it is possible to construct explicitly the Feynmann repre-

sentation of any observable for a value of the charge which differs by an infinitesimal amount from a given value, when this representation is supposed known for the given value of the charge. It is shown further how the divergencies which arise by varying the charge can be formerly eliminated by means of the renormalization. A.

530.145

2005. Introductory remarks on quantum electrodynamics. H. B. G. Casimir. *Physica*, **19**, 846–9 (*Sept.*, 1953).

Lecture at the Leyden Conference, followed by a discussion. With a definite value of $e^2/\hbar c$, the zero-point energy of the electromagnetic field can compensate the self-energy of the Lorentz electron of finite, arbitrary shape. W. A. HEPNER

530.145

2006. Non perturbation theory approach to renormalization technique. G. Källén. *Physica*, **19**, 850–8 (*Sept.*, 1953).

Lecture at the Leyden Conference, followed by a discussion. It is possible to define the renormalization programme of quantum electrodynamics without perturbation theory and to give implicit formulae for the renormalization constants, at least one of which can be shown to be infinite. W. A. HEPNER

530.145

2007. Problems of interpretation of quantum electrodynamics. L. Rosenfeld. *Physica*, **19**, 859–68 (*Sept.*, 1953).

Lecture at the Leyden Conference, followed by a discussion. An introductory survey of the self-energy problem and of the ideas of mass and charge renormalization and regularization is followed by a consideration of the contributions to the question of the divergence of the series expansions. It is concluded that quantum electrodynamics is most probably an essentially incomplete, "open", theory, and that its interpretation can only be developed in the sense of a correspondence with the limiting case of classical theory by successive approximations. The importance of the correspondence argument is illustrated by a discussion of the electrostatic field. W. A. HEPNER

530.145

2008. Isotopic spin and mass quantization. A Pais. *Physica*, **19**, 869–87 (*Sept.*, 1953).

Lecture at the Leyden Conference, followed by a discussion. The isotopic spin is incorporated in the wave equation of heavy particles whose invariance in isotopic spin space expresses charge independence and conservation of heavy particles, and which yields protons, neutrons and V-particles as possible states. With suitable correspondence between mass and spectral levels, and making the (pseudoscalar) interaction between the π-meson family and the heavy particle family invariant for the full group of isotopic spin space, the γ-stability and π-metastability of the V-particle are accounted for in a natural way. The lifetimes of multiply charged states are too short (10^{-21} sec) for direct detection, but these resonant states should markedly influence the energy dependence of such processes as π-H scattering or single and multiple meson production. The possibility is also envisaged of the existence of an electron spectrum to which the μ-meson and particles of higher mass should belong. W. A. HEPNER

530.145

2009. The Lorentz transformation and absolute time. P. A. M. Dirac. *Physica*, **19**, 888–96 (*Sept.*, 1953).

Lecture at the Leyden Conference, followed by a discussion. In quantum mechanics the concepts of ether velocity and absolute time can be used in a Lorentz-invariant theory. Giving physical significance to the motion of the space-like surface, it is thus possible to obtain a simplified Hamiltonian description of an irrotational electron stream in which there is no creation and annihilation of electrons and positrons. W. A. HEPNER

530.145

2010. Doubts and hopes in quantum electrodynamics. W. Heisenberg. *Physica*, **19**, 897–908 (*Sept.*, 1953).

Summarizing address in the final session of the Leyden Conference, 1953. The agreement between the predictions of the renormalized theory and experiments is very satisfactory, and this may also be true of the earlier untested result of scattering of light by light. However, considerations by Källén show the impossibility of the mathematical scheme being finite and simple. This leaves two possibilities: the theory is either "closed" (self-consistent without referring to other particles) or "open." High-energy collision phenomena seem to rule out the former and the open non-local theories, while in a purely local theory with small interaction the creation of several particles becomes too rare an event; a strong local interaction may thus have the best prospect of success. As a "kind of foundation for optimism" a simple non-linear first-order equation of local type is presented which, if it can be quantized and gives convergent results, may cover quite a number, or perhaps all, of the elementary particles and may yield their mass ratios as well as the coupling strengths. W. A. HEPNER

530.145

2011. Riesz potential and the elimination of divergences from quantum electrodynamics. L. S. Kothari. *Proc. Phys. Soc.* [*London*] *A*, **67**, 17–24 (*Jan.*, 1954).

Using a modified definition of Riesz potential it is shown that the divergencies arising in quantum electrodynamics from (i) the point nature of charge, (ii) the electron self-energy and (iii) the vertex part of a Feynman graph, can be eliminated in a consistent way, without having to introduce any cut-off factors or auxiliary fields. A.

530.145

2012. On mutual nucleon-nucleon interaction through meson fields. J. Werle. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 95–8 (1953).

The approximation method developed in an earlier paper [Abstr. 75 (1954)] is used to obtain the classical form of the interaction potential for the case of a non-derivative (but otherwise general) type of coupling. G. FIELD

530.145

2013. A note on many particle problems. T. Sasakawa. Note in *Progr. theor. Phys.*, **9**, 182–4 (*Feb.*, 1953).

For the transition of one n-particle state to another,

the matrix element of the interaction operator will contain terms multiplied by ± 1, corresponding to the even or odd character of the permutation of fermion operators in the expression. Formulae giving directly the number of terms having even and odd parity are quoted. These would be useful for the calculation of partition functions of almost classical assemblies and many-body problems involving many-body forces.

G. FIELD

530.145

2014. Covariant theory of radiation damping and the scattering of charged scalar mesons by nucleons. S. N. BISWAS. *Indian J. Phys.*, **27**, 197–207 (*April*, 1953).

It is shown that the strong increase of cross-section with the increase of energy which is a characteristic feature of all meson theories with derivative couplings and which remains unsolved from the covariant perturbation method of Feynman, can be removed by the inclusion of the influence of radiation damping. In this paper the Heitler integral equation for the positive meson by proton and that of negative meson by neutron is solved by the variational technique of Goldberger, using the scalar meson field with vector coupling. A comparison of this result with the previous one obtained from the same scattering process using pseudoscalar meson field with pseudoscalar coupling, solved by the semi-variational procedure of Hsueh and Ma, shows that for a proper fit to the experimental result obtained by Steinberger, the value of the coupling constant has to be lowered to one-third of the former value, 0·56, used by the author. The superiority of the variational technique of Goldberger to that of Ma and Hseuh is established by considering the scattering of negative meson by proton. It is found that the exact solution corresponds to the approximate solution of Goldberger. A.

530.145

2015. On the renormalization of the Tamm-Dancoff equation. H. LEHMANN. Note in *Z. Naturforsch.*, **8a**, 579–80 (*Sept.*, 1953) *In German.*

The Tamm–Dancoff method is shown to involve divergent expressions that cannot be interpreted as renormalization terms. R. A. NEWING

530.145

2016. Derivation and renormalization of the Tamm-Dancoff equations. B. KURSUNOĞLU. Letter in *Phys. Rev.*, **92**, 1069 (*Nov.* 15, 1953).

The derivation from the covariant Bethe–Salpeter equation can be greatly simplified, and covariant renormalizations can be achieved without the difficulties presented by the original T.D. method.

W. A. HEPNER

530.145

2017. Covariant Fock equations. P. T. MATTHEWS AND A. SALAM. *Proc. Roy. Soc. A*, **221**, 128–34 (*Jan.* 7, 1954).

A new type of amplitude—Feynman amplitude—is defined for any state. These amplitudes are shown to propagate in the Feynman manner. It is shown further that they satisfy an infinite set of four-dimensional, covariant, coupled integral equations, analogous to the three-dimensional Fock equations between the ordinary probability amplitudes. A.

530.145

2018. Charge renormalization and the identity of Ward. G. KÄLLÉN. *Helv. phys. Acta*, **26**, *No.* 7–8, 755–60 (1953).

The importance of the identity of Ward for the consistency of the charge renormalization is pointed out. A proof of the identity is given without aid of perturbation theory. A.

530.145

2019. Note on the non-relativistic approximation for particles of spin 3/2. A. DA SILVEIRA. *An. Acad. Brasil Ciênc.*, **25**, *No.* 2, 197–9 (1953).

The equivalence of the Pauli–Fierz and Rarita–Schwinger equations in the non-relativistic approximation is demonstrated. G. FIELD

530.145

2020. Has the isotopic spin any sense for light particles? M. CINI AND A. GAMBA. *Nuovo Cimento*, **10**, 1040–6 (*Aug.*, 1953).

The possibility of extending the concept of isotopic spin to muons, electrons and neutrinos produced in the pion decay, muon decay, β-decay and nuclear capture of the muon is investigated. If these reactions are charge independent it follows that the isotopic spin 1/2 must be assigned to all fermions. Furthermore the β-decay neutrino must be different from the pion decay neutrino, which has to be properly denoted as neutretto. Some reactions by means of which the hypothesis of charge independence could be tested are proposed, but they are all far beyond the present experimental possibilities. A.

530.145

2021. Contribution to the theory of the physical quantities associated with particles of spin $\frac{1}{2}$. J. WINOGRADZKI. *Ann. Phys.* [*Paris*] **8**, 763–812 (*Sept.–Oct.*, 1953) *In French.*

The properties of physical quantities (associated with particles of spin $\frac{1}{2}$) whose operators act only on the spin variable and are invariant to proper Lorentz transformations, are examined on the assumption that their mean value densities are tensors. The Dirac equation need not be employed; the general principles of wave mechanics and the laws of transformation of the wave equation suffice to determine and classify the ensemble of physical quantities so defined, and to examine their properties and the structure of their operators. A sub-group of such quantities, characterized by the invariance of their operators to Lorentz transformations of all types, correspond to the classical physical quantities.

P. M. DAVIDSON

530.145

2022. Magnetic moments of neutron and proton. F. J. BELINFANTE. *Phys. Rev.*, **92**, 994–7 (*Nov.* 15, 1953).

After a discussion of the importance of results recently found by Sachs [Abstr. 7970 (1952)], some weaknesses of his theory are pointed out, and a contribution to the nucleon magnetic moment from the state with two-pion cloud in an S-state is calculated. A proposal of Sugawara to include admixtures of states with a one-pion cloud around a spin-$\frac{3}{2}$ ("baryon") core is criticized, and the contribution of such states to the nucleon magnetic moments is

calculated. It is discussed what value might be taken for the magnetic moment of such "baryon" core. A.

530.145

2023. The interpretation of Bhabha's theory of particles of maximum spin 3/2. W. A. Hepner and D. R. Workman. Letter in *Phys. Rev.*, **92**, 1071 (*Nov.* 15, 1953).

Analysis of the problem of reflection and transmission at a potential barrier shows that the higher mass particles of negative normalization manifest themselves as members of unreal created pairs whose contribution should be subtracted in the physical interpretation. Within certain relativistic energy regions (as well as in the non-relativistic region where the particles behave like Dirac electrons) the ordinary probability interpretation can still be applied directly to give results which, in more realistic problems, may lead to tests of the theory regardless of questions of interpretation in other regions. W. A. HEPNER

530.145

2024. The relativistic description of bound states. K. Baumann. *Acta phys. Austriaca*, **8**, *No.* 1, 4–15 (1953) *In German.*

The relativistic two-body problem in field theory is considered. Relations between the Tamm–Dancoff equation and the Bethe–Salpeter equation are discussed in detail. G. E. BROWN

530.145

2025. Selection rules for meson decays into two bosons imposed by the conservation of angular momentum and parity. B. Jakšić. *Period. math-phys. astron.* [*Zagreb*] **8**, 149 (1953).

A complete list of selection rules for distinguishable and indistinguishable bosons is given, obtained by Michel's group-theoretical method. G. FIELD

530.145

2026. Charge independence of nuclear interaction and high energy nucleon-nucleon scattering. J. Iwadare. Letter in *Progr. theor. Phys.*, **9**, 93–4 (*Jan.*, 1953).

A qualitative discussion of the scattering with various nuclear forces is given in the isotopic spin formalism. G. E. BROWN

530.145

2027. The effect of the excited states of nucleons in high energy nucleon-nucleon scattering. J. Iwadare. Letter in *Progr. theor. Phys.*, **9**, 94–5 (*Jan.*, 1953).

530.145

2028. On the relativistic two-body problem. S. Hori. Note in *Progr. theor. Phys.*, **9**, 184 (*Feb.*, 1953).

A short note to show the relation between the bound-state problem and the S-matrix, giving a further restriction for the energy eigenvalues. G. FIELD

530.145

2029. On the gauge invariance of the neutral vector meson theory. R. J. Glauber. *Progr. theor. Phys.*, **9**, 295–8 (*March*, 1953).

The neutral vector meson theory is discussed in a way which, by exploiting its similarity to quantum electrodynamics, simplifies the transition to vanishing meson rest mass. In particular the gauge invariance of electrodynamics is shown to be a special case of an invariance holding more generally in the meson theory. A.

530.145

2030. On the reaction of the mesonic proper field. S. Goto, R. Kawabe and M. Takasu. *Progr. theor. Phys.*, **9**, 312–20 (*March*, 1953).

The process of pion nucleon scattering and photoproduction of positive pions are calculated with pseudovector coupling in pseudoscalar theory by using the corrected nucleon propagation function obtained from the prescription of the non-singular theory proposed by Kamefuchi and Umezawa. It is shown by this calculation that, in this non-singular theory, (i) the pole appears in the corrected propagation function and (ii) difficulties with respect to the gauge invariance occur. A.

530.145

2031. Scattering problems with spin-orbit couplings. T. Regge and M. Verde. *Nuovo Cimento*, **10**, 997–1011 (*Aug.*, 1953).

With the aim of treating the scattering of neutrons by deuterons in presence of tensor forces or spin-orbit couplings a variational principle is given which does not use Green's tensor. The method is an extension of that due to Hulthén for the case of two bodies and central forces [Abstr. 3110 (1948)]. The two-body case with tensor potentials, the three-body case with central forces and the more general case of neutron-deuterons scattering with spin-orbit coupling are all discussed. A.

530.145

2032. Semiclassical theory of the scattering of π-mesons on nucleons. E. Fabri. *Nuovo Cimento*, **10**, 1367–74 (*Oct.*, 1953) *In Italian.*

The scattering of π-mesons on nucleons is studied using the natural extension of Pauli's method, and the involved approximations are discussed. As charge is unquantized, difficulties arise in the interpretation of the result, which are overcome by imposing correspondence with the quantum theory. The cross-sections so attained coincide with the quantum ones in perturbation limit; however, it does not seem possible to fit the experimental results by this method. A.

530.145

2033. Note on a paper by H. L. Jordan. G. Höhler. Note in *Z. Naturforsch.*, **8a**, 677 (*Oct.*, 1953) *In German.*

It is stated that a formula derived by Jordan [Abstr. 7446 (1953)] leads to a result given by the author [Abstr. 8529 (1951)]. W. A. HEPNER

530.145

2034. The invariant forms of the nucleon-nucleon interaction. D. Feldman. *Phys. Rev.*, **92**, 824–6 (*Nov.* 1, 1953).

The invariant scattering matrix is used as a basis for the derivation of the possible forms of nucleon-nucleon interaction. The method has the particular advantage that it allows for a systematic treatment of both exchange and non-exchange forces. A.

530.145

2035. Solutions of the meson-nucleon equation in the adiabatic limit. R. Arnowitt and S. Deser. Letter in *Phys. Rev.*, **92**, 1061 (*Nov.* 15, 1953).

The stability of meson-nucleon systems and scattering are investigated for isotopic spin 3/2 with the

lowest order interaction in the adiabatic limit. The relativistic equation is reduced to a three-dimensional form and both large and small spinor components are retained. G. FIELD

530.145

2036. The binary rearrangement collision. S. ALTSHULER. *Phys. Rev.*, **92**, 1157–9 (*Dec.* 1, 1953).

The theory of the general binary collision is discussed, and it is demonstrated that the rearrangement scattered amplitude can be derived from the integral equation which is convenient for determining the direct (no rearrangement of particles) scattered amplitudes. As a consequence, it is shown that no ambiguity in matrix element for the rearrangement amplitude in Born approximation exists. A.

530.145

2037. A note on perturbation theory. J. RZEWUSKI. *Acta phys. Polon.*, **11**, *No.* 2, 179–88 (1952).

The identity of the results of the new and the old perturbation theory is shown by a direct transition. Feynman's method is presented in a simple form based on integral equations which is evidently invariant not only in the results but throughout the derivation. The problem of scattering on bound states is treated by means of the modern techniques. A.

530.145

2038. Remarks on the formulation of quantum mechanics with classical pictures and on relations between linear scalar fields and hydrodynamical fields. T. TAKABAYASI. *Progr. theor. Phys.*, **9**, 187–222 (*March*, 1953).

The formulation of quantum mechanics in terms of the picture of trajectory ensemble or of the hydrodynamical picture, developed in a previous article [Abstr. 8242 (1953)], is further supplemented for some points. Individual trajectories for some typical non-stationary state are explicitly obtained, illustrating that they generally show complicated fluctuations due to the action of quantum potential. Next, emphasis is placed on the fact that the Schrödinger field admits a mechanical model. Also the Klein–Gordon field is represented with a quasi-irrotational flow under some additional scalar field. This representation of Klein–Gordon field suggests its possible generalization to include the vortical motion. Such treatments of interacting Klein–Gordon and electromagnetic fields involve the formalism of Dirac's recent classical electrodynamics as a limiting case. This Dirac theory is briefly discussed. Finally, the picture of trajectory ensemble is generalized so as to represent wave equations with sources. The attempt to interpret quantum mechanics in terms of Markoff process is criticized. A.

530.145

2039. Miscellanea in elementary quantum mechanics. I. K. HUSIMI. *Progr. theor. Phys.*, **9**, 238–44 (*March*, 1953).

Examples of more or less novelty and interest from a course of undergraduate lectures on quantum mechanics. A.

530.145

2040. A quantum theory of boson assemblies. II. A classical approach to many-boson problems. T. NISHIYAMA. *Progr. theor. Phys.*, **9**, 245–67 (*March*, 1953).

For Pt I, see Abstr. 55 (1954). Some collective behaviours of boson assemblies are described in terms of the classical density operator and the classical velocity operator. These two classical quantities are introduced by taking an average of the quantized operators with respect to Heisenberg wave packets. Equations of these two quantities are determined and the transport equations obtained. Thus the assembly is described as a fluid having the quantum mechanical pressure tensor. The collective behaviour of the assembly in question is analysed applying the theory of sound waves. Such an approximate treatment allows the assembly in question to be regarded as the assembly of oscillation quanta. When a particle is projected into the assembly with the velocity v_0 which is larger than the sound speed of the medium, suffering the collective response of the remainder of the bosons, the particle is decelerated and emits sound quanta. These processes are analysed by a classical treatment. Further, the interaction is considered of every particle in the assembly with the field of the collective oscillation representing behaviours of the remainder of the assembly. The self-energy of the particle and the Møller interaction between particles are obtained according to the interaction representation of Tomonaga and Schwinger as well as the canonical transformation of Bloch and Nordsieck. A.

530.145

2041. Comments on an article of Takabayasi concerning the formulation of quantum mechanics with classical pictures. D. BOHM. *Progr. theor. Phys.*, **9**, 273–87 (*March*, 1953).

Certain of Takabayasi's criticisms [Abstr. 8242 (1953)] of a causal reinterpretation of the quantum theory are answered in detail. It is indicated how this interpretation can be extended to the Dirac equation and the problem of the identity of equivalent particles is discussed for the case of particles that satisfy the Pauli principle. Possible extensions of theory are indicated. Finally, criticisms at the philosophical level are discussed, especially the question of what it means to call a theory "metaphysical" and the reasons why the concept of causality is indispensable in scientific theories. A.

530.145

2042. An augmented plane wave method for the periodic potential problem. J. C. SLATER. *Phys. Rev.*, **92**, 603–8 (*Nov.* 1, 1953).

A new method is proposed for solving a periodic potential problem in which the potential can be approximated as a constant outside sphere surrounding the atoms, spherically symmetrical within the spheres. Unperturbed functions were set up consisting of a plane wave outside the spheres, joined continuously and with continuous derivative to functions derived from the spherical problem within the spheres. These spherical solutions are linear combinations of eigenfunctions of Schrödinger's equation within the spheres, subject to the boundary conditions that the logarithmic derivative of the function of each l value at the surface equals the

logarithmic derivative of the corresponding Bessel function in the expansion of the plane wave, thereby insuring continuity of the derivative of the wave function over the sphere if the function itself is continuous. The coefficients in the expansion within the spheres are determined by demanding that the expectation value of the energy of the wave function be stationary when the coefficients are varied. The secular equation connected with this variation problem can be solved exactly, leading to wave functions having the general character of orthogonalized plane waves. A linear combination of such functions is then used to build up an approximate solution of Schrödinger's equation. It is shown that the tightly-bound states are handled quite differently from the conduction band, and that the treatment of the conduction band can well resemble the free-electron approximation, thereby perhaps explaining the empirical success of the free-electron approximation for the conduction electrons in metals. The method can be extended to a case where the potential does not have the simple behaviour postulated, by treating the difference between the actual potential and the postulated form as a perturbation. A.

530.145

2043. The single-time Bethe-Salpeter equation. W. MACKE. Letter in *Phys. Rev.*, **92**, 1072 (*Nov.* 15, 1953).

Two ways of obtaining the equation for the single-time form of the B.S. wave function for two particles in positive free energy states are outlined.

W. A. HEPNER

530.145

2044. The Bohr formula for nonrelativistic elliptic orbits. H. GOLDSTEIN. Note in *Amer. J. Phys.*, **21**, 688 (*Dec.* 1, 1953).

The Bohr energy for elliptic orbits is expressed in terms of the principal quantum number by employing the virial theorem. This circumvents the usual evaluation of the radial phase integral. G. E. BROWN

530.145

2045. Solution of the wave equation near an extremum of the potential. C. J. MULLIN. Letter in *Phys. Rev.*, **92**, 1323–4 (*Dec.* 1, 1953).

The wave equation in one dimension is taken. A more accurate solution than those previously given is obtained. This has numerous applications, e.g. near the maximum of a potential barrier it determines accurately the transmission coefficient of particles having energies nearly equal to the height of the barrier. L. S. GODDARD

530.145.6

2046. On the problem of the separability of variables. A. CARRELLI. *Nuovo Cimento*, **10**, 1213–18 (*Sept.*, 1953) *In Italian.*

After referring to the typical case of Liouville's variable separation, that of Stäckel is analysed, showing how it is met in the Stark effect, and the wave mechanics interpretation is given. Further examination of subsequent work, in which Agostinelli has resolved the separation problems shows in Levi Civita's case the geometrical analogy between this general case and the classical one. A.

530.162

2047. Some theorems in the theory of Brownian motion which apply to the excluded volume problem in polymer chains. R. J. RUBIN. Letter in *J. chem. Phys.*, **21**, 2073 (*Nov.*, 1953).

These theorems concern the density of the set of the paths, and the number of their double points, in Brownian motion in n dimensions, $n \geqslant 2$. Conclusions may be drawn concerning the mean square distance $\langle R_N^2 \rangle$ between any two steps in a random walk when $n = 2$ or 4; when $n = 3$, however, the conclusion is that more refined methods are needed to find the dependence of $\langle R_N^2 \rangle$ upon N when there is a finite excluded volume. A. J. TAYLOR

530.162 : 536.7

2048. The statistical mechanics of irreversible processes. III. G. KLEIN AND I. PRIGOGINE. *Physica*, **19**, 1053–71 (*Nov.*, 1953) *In French.*

For Pt II, see Abstr. 6493 (1953). Studies the statistical mechanics of irreversible processes in linear assemblies of harmonic oscillators where nearest neighbours only are interacting. The equations of motion are solved in terms of the initial conditions of the system and these are subjected to probability distributions. The change of the distribution functions with time is described in some detail and the asymptotic behaviour after large times is investigated. Particularly simple asymptotic results can be obtained for infinite systems and by restricting the initial distribution function to a product of uncorrelated distribution function of the different variates (velocities, relative distances). The physical significance of such initial factorized distribution functions in terms of normal modes is indicated. It is shown that such distribution functions correspond to initial states for which equipartition of energy between the different normal modes is already achieved. On the other hand, the distribution of phases is initially not the equilibrium random distribution. In this case it can be shown that each finite part of the system tends asymptotically to statistical equilibrium owing to mechanical interaction with its surroundings. In particular, the velocity distribution of each particle and the distribution of distance between any two neighbouring particles tend to the appropriate Gaussian equilibrium distributions; equipartition of kinetic and potential energy is demonstrated. This last result holds also under more general conditions. The limiting process involved in passing from the infinite to the finite system is considered and it is shown that for sufficiently short time the behaviour of a finite system is the same as that of an infinite one. The asymptotic distribution functions evaluated furnish an illustration of the central limit theorem of statistics: owing to the dependence of phase velocity on wavelength, after a long time a larger and larger number of the random variables which describe the initial conditions will contribute to the distribution function of any finite part. Thus the conditions of the theorem become satisfied—this is in sharp contrast to the case of a continuous system in which there is only a single velocity of propagation. The superposition principle of Kirkwood is discussed: it is shown not to be valid

out of equilibrium as it prevents the correct propagation of mechanical disturbance through the system. It is, of course, always possible to postulate a factorization of the initial distribution function for the complete system, but such a factorization is generally not maintained with time although it reappears asymptotically. The relation between the results obtained here and the ergodic theory is briefly indicated. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.252.2

2049. On the distribution of initial stress due to dislocation in an infinite plate containing two unequal circular holes. B. KARUNES. *Indian J. Phys.*, **26**, 317–28 (*July*, 1952).

Solutions are obtained for two problems on the state of initial stress. The dislocations are due to (1) a parallel fissure joining the two circular holes or joining each hole to infinity and (2) two opposite kinds of wedge shaped fissures of the same apex-angles, on two sides of the x-axis. Cases of equal holes in each of these problems are treated as particular examples and tables for numerical values of the constant coefficients when the hole boundaries are $\alpha = 0{\cdot}8$ and $\alpha = -0{\cdot}8$ are given. Graphs showing the stresses are drawn and discussed. A.

531.252.2

2050. A note on the problem of dislocation in a semi-infinite plate containing a circular hole. B. KARUNES. *Indian J. Phys.*, **26**, 442–4 (*Sept.*, 1953).

A stress function giving the stress distribution due to dislocation in a semi-infinite plate containing an unstressed circular hole near the straight edge of the plate is obtained in bipolar co-ordinates after the work of Ghosh on the problems of dislocation in a circular plate containing an eccentric hole. The circumferential stresses over the hole boundary and the straight edge are calculated. A.

531.258

2051. On the concentration of stress round the edge of a hole bounded by two intersecting circles in a large plate. B. KARUNES. *Indian J. Phys.*, **27**, 208–12 (*April*, 1953).

A stress function in bipolar co-ordinates is obtained to give the distribution of stress round the edge of a hole bounded by two intersecting circles in an infinite plate under uniform shear in the plane of the plate; and some particular cases are discussed. A.

531.66

2052. The motion of struck bodies. H. MAECKER. *Naturwissenschaften*, **40**, *No.* 20, 521–2 (1953) *In German.*

This article briefly discusses the physics of impacts and describes two methods of demonstrating the principles. Spark photography is used to photograph the effects produced when a small explosive charge is fired in water close to Al rods of different sectional area. The motion of one end of a rod, the other end of which is in water close to a small charge is photographed by projecting an enlarged image on to a rotating drum. H. J. H. STARKS

MECHANICAL MEASUREMENTS 531.7

531.717 : 539.62

2053. An apparatus for recording surface friction and irregularity. P. F. D. NAYLOR. Letter in *J. sci. Instrum.*, **30**, 389–90 (*Oct.*, 1953).

Apparatus designed to measure frictional trauma required to produce blisters and other frictional properties of healthy and diseased skin. Also used for measuring surface contours and irregularities. J. W. MENTER

531.717.1

2054. Thickness gauges, particularly for strip measurement in rolling mills. I. Induction and X-ray types. N. DE BALL. *Arch. tech. Messen, Issue No.* 213 (*Ref. V*1124–4) 219–22 (*Oct.*, 1953) *In German.*

Brief descriptions are given of the following: Inductive types: Karajan (Austria), Pratt and Whitney, A.E.G. X-ray types: General Electric (U.S.A.), Westinghouse (U.S.A.), Wuppermann. C. F. PIZZEY

531.717.7

2055. The measurement of the radius of curvature of test glasses with the ring spherometer. J. PICHT. *Optik*, **10**, *No.* 9, 423–5 (1953) *In German.*

When measuring the radius of curvature of a pair of test glasses, known to have the same curvature by interference, it is usual to substitute the arithmetic mean values of the sagitta and the ring radius in the spherometer equation. It is shown that a geometric mean value of the inner and outer ring radius should be used and that the value of the correction term is then very small. R. W. FISH

531.718

2056. Pneumatic gauging applied to the measurement of the bore of tube. R. CHITTLEBURGH, E. F. POWELL AND G. F. MORTON. *J. sci. Instrum.*, **31**, 20–2 (*Jan.*, 1954).

A method is described which enables the core of a tube to be measured accurately at all positions along the length of the tube. The method is particularly suited to the measurement of the bore of tube manufactured to close tolerances. With a method of amplification incorporated into the system, it is possible to determine whether the bore of tube having large tolerances, e.g. $\frac{1}{2}$ in. bore with a tolerance of $+1/32$ in., lies within those tolerances. A steel ball is placed within the tube and held in position by an electromagnet. The ball serves as the second constriction in a pneumatic system, air at constant pressure being supplied to one end of the tube through a first constriction of fixed size. The pressure developed between the two constrictions is a measure of the gap between the steel ball and the inner wall of the tube. A.

531.719.33

2057. A bed level indicator for detecting the boundary of a body of water. M. J. WILKIE AND R. F. J. KING. *J. sci. Instrum.*, **31**, 8–9 (*Jan.*, 1954).

Solid material in suspension often makes it im-

possible to observe visually the position of the bed of a hydraulic model. The change of impedance between two electrodes as they are approached to the bed is the basis of the portable, battery-operated instrument described. A bridge circuit is used with headphones to detect the balance point. A.

531.752

2058. A microbalance for the determination of protein crystal densities. F. M. RICHARDS. *Rev. sci. Instrum.*, **24**, 1029–34 (*Nov.*, 1953).

A microbalance has been developed for the simultaneous measurement of the apparent weight and volume of a single protein crystal immersed in its mother liquor. The crystal density, computed from these values, is not subject to the errors, resulting from an altered environment, which are present in the usual flotation procedures. The technique, moreover, may also be used for following the volume and density changes which occur on changing the composition of the immersing liquid. The sensitivity is easily controlled by the choice of the diameter of the fibre used in the weighing mechanism. This balance may be of use in other systems where the apparent weight and/or volume of an object, immersed in a liquid of known composition, is required. A.

531.756 : 621.317.49

2059. An electromagnetic method of measurement of density or specific gravity of liquids. K. R. HONICK. *J. sci. Instrum.*, **31**, 1–2 (*Jan.*, 1954).

The instrument described determines the sp.gr. of liquids by measuring the minimum electromagnetic force in terms of current required to attract an immersed float through a fixed distance. The float contains a soft iron armature and its sp.gr. is arranged to be either slightly greater or less than the extremes in the range required to be measured, according to whether the float is attracted upwards or downwards through the liquid. The method permits remote indication or recording by a conventional moving-coil meter or pen chart recorder if the motion of the float is arranged to actuate a signal such as the completion of an electrical circuit. A simple manually operated form for non-electrolytes of low viscosity is described; the method can, however, be extended to other liquids and could be made to operate automatically on a cyclic basis. Fundamentally, the method measures density; the application described is scaled in terms of specific gravity. A.

531.768 : 531.787

2060. Theory of the manometer accelerometer. D. STEEN AND D. CASEY. *Rev. sci. Instrum.*, **24**, 1021–8 (*Nov.*, 1953).

The possible use of U- and O-tube manometers as extremely accurate and sensitive accelerometers is investigated. It is found that their steady-state fluid-level displacement is linearly related to the applied acceleration. Both the Navier–Stokes equation and Lagrange's equation are used to derive the equation of motion of the fluid level for a multiple cross-section tube. Nonlinear terms are derived to represent the turbulence introduced by change of cross-section. Means of obtaining an overdamped, nearly linear, long time-constant accelerometer are discussed. A study of the effect of design on response reveals that almost any desired specifications can be achieved by an appropriate modification of structure and/or fluid medium. Experimental tests, conducted on a platform vibrated in a one-dimensional sinusoid by a rotating cam, confirm predictions based on the theory. A.

531.787

2061. Liquid manometers with high sensitivity and small time-lag. F. A. MACMILLAN. *J. sci. Instrum.*, **31**, 17–20 (*Jan.*, 1954).

For some purposes a sensitive manometer is required having a small time-lag when connected to a small bore tube or orifice. The time-lag which can be tolerated is limited by the rate of change of the zero reading. Some problems in the design of a manometer with small time-lag and small rate of change of zero reading are discussed, and some general principles of design are derived. It is shown that with a null-reading inclined-tube manometer, changes of zero reading due to variation of temperature can be eliminated by correct choice of the manometer dimensions. A.

531.791 : 541.182.3

2062. The reduction in apparent particle concentration with multiple strokes of the Owen jet dust counter. J. K. DONOGHUE AND C. MACK. Note in *Brit. J. appl. Phys.*, **4**, 316–17 (*Oct.*, 1953).

Results are given of an investigation of dust in the cardroom of cotton spinning mills. The observed effects are attributed to blowing-off and it is suggested that the observed average number of particles per cm^3 (C_n), of the particular size concerned, is linearly related to the reciprocal of the number of strokes (n). The regression line for C_n on $1/n$ gives an easily determined correction curve which appears to be sufficiently accurate for practical purposes.

G. F. HODSMAN

MECHANICS OF FLUIDS 532

532.13

2063. Some general relations on the viscosity of homologous liquids. S. R. PALIT. *Indian J. Phys.*, **26**, 627–36 (*Dec.*, 1952).

From recent theoretical developments in the field of viscosity of liquids as explained from the hole theory of liquid structure, the following relations have been deduced. (1) In any homologous series, at constant temperature, the logarithm of the molecular viscosity ($\log \eta M$) is a linear function of the molar surface energy $\gamma(Mv_{sp})^{2/3}$. It is shown that the theoretical slope of this line is $0{\cdot}17 \times 10^{-2}$ and the observed slope for different homologous series is within a factor of two of this theoretical value. (2) In any homologous series if the intercept of the Arrhenius plot (i.e. $\log \eta\, vs^{1/T}$) is A, log molecular weight is in linear relation with A, the slope of the line being negative of unity, i.e. (i) $A = -\log M + \text{constant}$ or (ii) $M = K\eta 10^{-A}$. It is pointed out that the experimental results with methyl esters confirm the above equation, the observed slope being $-1{\cdot}01$ and

that the relation can evidently be utilized for determining molecular weight of liquids from viscosity measurements. There are too many exceptions to this equation which limits its utility but points to the soundness of the basic concept. (3) In any homologous series, $\ln \eta/K_E T_C$ (where K_E = Eötvos constant $\simeq 2{\cdot}1$ and T_e = critical temperature) plotted against $1/T$ would produce a system of parallel straight lines with a slope of near about unity. (4) In any homologous series log molar viscosity plotted against reciprocal of absolute temperature would produce a system of straight lines which would all meet at near about the same point on the log molar viscosity axis. The application of this relation to the establishment of chemical structure is obvious. The above relations are further simplified and applied in the case of high polymers. All the above deductions have been found to be in conformity with the available experimental data. A.

532.13 : 530.162

2064. The statistical mechanical theory of transport processes. VI. A calculation of the coefficients of shear and bulk viscosity of liquids. R. W. Zwanzig, J. G. Kirkwood, K. F. Stripp and I. Oppenheim. *J. chem. Phys.*, **21**, 2050–5 (*Nov.*, 1953).

A theory of the coefficients of shear and bulk viscosity of liquids is applied to the calculation of the coefficients of viscosity of liquid argon at its normal boiling point. The theory of the bulk viscosity, including a previously omitted term due to the rate of dilatation, is presented. With the use of the Lennard–Jones potential, a radial distribution function which is a much better approximation than the previously used one, and a new approximation to the friction constant, values are obtained for the coefficients of viscosity. A.

532.51

2065. The depression of liquid surfaces by gas jets. R. D. Collins and H. Lubanska. *Brit. J. appl. Phys.*, **5**, 22–6 (*Jan.*, 1954).

A gas jet directed on to a liquid surface causes considerable agitation of the liquid, a fact which is largely responsible for the rapidity of the steel-making reactions in the side-blown convertor as compared to the open-hearth furnace. As a start for laboratory investigation of this effect, the disturbance caused by an air jet playing on a water surface was photographed. The maximum depth of penetration was measured and plotted against the calculated reaction thrust, $\rho Q^2/A$, for a range of jet direction, orifice diameter, distance of orifice from water surface and air velocity. The consistency of the results within the practical limits of experimental error suggested an empirical relationship between the variables for angles between jet and surface above about 25°, and the following equation was derived expressing penetration as a function of thrust and angle of jet: $P = 53\tau \sin\theta/[x^2\omega + 19(\omega\tau^2)^{\frac{1}{3}}]$. A.

532.51 : 534.39

2066. Acoustic streaming near a small obstacle. P. J. Westervelt. *J. Acoust. Soc. Amer.*, **25**, 1123 (*Nov.*, 1953).

Steady rotational flow is known to occur in the vicinity of a smooth rigid object oscillating to and fro in a viscous incompressible fluid. For a small oscillation amplitude the steady flow is shown theoretically to be invariant to the co-ordinate transformation which renders the object stationary. A.

532.51 : 537.3

Variational methods for problems in resistance. *See Abstr.* 2415

532.517

2067. Direct determination of the flow curves of non-Newtonian fluids. III. Standardized treatment of viscometric data. I. M. Krieger and S. H. Maron. *J. appl. Phys.*, **25**, 72–6 (*Jan.*, 1954).

For Pt II, see Abstr. 2990 (1953). A scheme is proposed for systematizing the handling of viscometric data through use of the variables: apparent fluidity ϕ_a and shearing stress F. The rate of shear $g(F)$ is obtained from the relation: $g(F)/F = \phi_a[1 + \Delta(F)]$. Methods are presented for obtaining the correction term $\Delta(F)$ from capillary and concentric-cylinder viscometric data. Use of the proposed scheme is illustrated. A.

532.517.2

2068. Mass transfer in laminar flow. D. B. Spalding. *Proc. Roy. Soc. A*, **221**, 78–99 (*Jan.* 7, 1954).

Starting from the differential equation of mass transfer in laminar flow and the appropriate boundary condition, expressions are derived for the rate of mass transfer from (*a*) a flat plate in a longitudinal fluid stream, (*b*) a vertical flat plate by natural convection, (*c*) the forward stagnation point of a sphere in a fluid stream. Only outward mass transfer is considered; this corresponds to blowing outwards from the plate at a rate inversely proportional to the boundary-layer thickness. The Kármán–Pohlhausen–Kroujiline method is used. Where appropriate the Prandtl or Schmidt number has been taken as 0·71. The calculations are valid for all mass-transfer processes for which a single diffusion coefficient can be ascribed to the diffusing property, but are particularly relevant to the combustion of liquid fuels, for which the outward mass-transfer rates are so high that important deviations occur from boundary-layer profiles without mass transfer. Despite the great temperature variations present in boundary layers with combustion, mean values for the fluid properties are assumed. In the case of natural convection, it is assumed that the body forces on the fluid in the boundary layer are everywhere zero; this leads to a less serious over-estimate of the buoyancy than the usual assumptions which are valid only for small temperature differences. A.

532.517.2

2069. Mass transfer from a laminar stream to a flat plate. D. B. Spalding. *Proc. Roy. Soc. A*, **221**, 100–4 (*Jan.* 7, 1954).

The Kármán–Pohlhausen–Kroujiline method is used to calculate the mass-transfer rate from a laminar stream to a flat plate, for fluids of which the diffusion coefficient is not greatly different from the kinematic viscosity. Particular attention is paid to the very high rates of mass transfer occurring when the transfer number B approaches -1; under these circumstances

it is shown that the transfer rate is proportional to $(1 + B)^{-\frac{1}{2}}$. In aerodynamic terms the problem may be regarded as that of a laminar boundary layer with suction distributed in proportion to the reciprocal of the square root of the distance from the leading edge. A.

532.52

2070. A tea-pot effect. M. REINER. *Bull. Res. Coun. Israel*, **2**, 265–6 (*Dec.*, 1952).

Arguments and experimental results are adduced to show that (i) the pronounced tendency of the stream of tea to cling to the underside of the spout is not a surface tension effect; (ii) water can support one-dimensional stresses possibly because it acts as a kind of polycrystal with an intercrystalline amorphous phase. [See also Abstr. 1104 (1954).] S. J. GREGG

532.52

2071. On the stability of fluid flows with spherical symmetry. M. S. PLESSET. *J. appl. Phys.*, **25**, 96–9 (*Jan.*, 1954).

The conditions for the stability or instability of the interface between two immiscible incompressible fluids in radial motion are deduced. The stability conditions derived by Taylor for the interface of two fluids in plane motion do not apply to spherical flows without significant modifications. A.

532.528 : 532.7 : 536.423.1

Theory of the formation of bubbles. *See Abstr.* 2364

532.528 : 534.39

2072. Investigation of cavitation by sound in liquids. *Akust. Beihefte, No.* 4, AB 208–AB 218 (1952) *In German.*

The cavitation by sound has been investigated in liquids with different contents of nuclei in a frequency range from 0 to 3·3 Mc/s. The noise caused by the cavitation at the frequencies 3, 15, 175, 250, 365, 500 and 3300 kc/s of the exciting sound has been analysed over a broad frequency band including the exciting frequency. Apart from the well-known continuum and the harmonics of the excitation frequency, lines corresponding to the subharmonics have been observed. Measurements of the sound pressure necessary to produce cavitation yielded that this pressure depends considerably on frequency at frequencies above 15 kc/s. At a frequency of 500 kc/s the pressure necessary to start cavitation in fresh blood has been determined. In animal tissue no cavitation could be observed even at the highest sound intensities available. A.

532.528 : 534.39

2073. The relation between cavitation limit and hydrostatic pressure. J. H. JANSSEN. Letter in *Akust. Beihefte, No.* 4, AB 257–AB 258 (1952); erratum *Acustica*, **3**, 104 (1953) [=*Akust. Beih., No.* 1 (1953)]. *In German.*

The unexpected change in the tensile strength of fresh water under varying pressure, as measured by Lange, might be caused by change of the wave impedance of the water. A.

532.570.8

2074. Electromagnetic flowmeter. M. ROBIN. Note in *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 187–9 (1953).

A constant magnetic field, of intensity H, induces in a conducting liquid (mercury) of magnetic permeability μ, flowing in a tube of diameter D, with a velocity V_m normal to the field, a maximum potential drop given by $10^{-8}\,\mu HDV_m$. In the construction of a flowmeter, based on this principle, the body of the meter is made of a cylinder of Plexiglas of ext. dia. 20 mm pierced with a channel of dia. 4 mm, joined to a stainless steel conduit of 4 mm int. dia.; the magnetic field is provided by an 8 mm air-gap between two permanent magnets made of an alloy (Ticonal) of high coercivity. The potential difference is measured by means of a potentiometer, provided with brass electrodes arranged directly opposite the Plexiglas body. Experimental results confirm the theory of the instrument. J. S. G. THOMAS

532.593 : 551.556

2075. The generation of wind waves on a water surface. C. ECKART. *J. appl. Phys.*, **24**, 1485–94 (*Dec.*, 1953).

The statistical methods for treating continuous media developed elsewhere are applied to the generation of surface gravity waves. The wind stress is assumed to be everywhere normal to the disturbed surface of the water and caused by a known ensemble of "gusts." Each gust is considered to be a centre of high or low pressure, which moves with the mean wind speed, and has a radius L, and duration T. The r.m.s. value of the variable wind pressure is assumed to vary systematically from point to point in a storm. The calculations are made for an idealized, long continuing storm; before applying the statistical equations, the effect of a single gust is calculated. It is shown that the single gust produces a V-shaped wake, which, after the gust has blown itself out ($t > T$) can be considered as a packet of free gravity waves, which moves and spreads under the influence of divergence and dispersion. The results of the statistical calculation are compared with known general facts, and with an actual storm. From the fact that the storm waves have a non-sinusoidal character, and arrive at any one point in groups of 5 to 10 crests, it is deduced that the duration of a gust is from 15 to 30 sec. From the fact that the majority of the wave energy travels in directions that are within 30° of the wind, and with phase velocities that are nearly equal to the wind speed, the mean radius of the gusts is deduced to be about 40 m in the case of a wind speed of 20 m per sec. The crest length of the waves is proportional to the distance r from the storm, and inversely to its diameter, D; when $r/D = 10$, the dominant length of the crests is 2·2 wavelengths. The r.m.s. displacement, H, of the sea-surface from its horizontal mean is a function of the parameters already mentioned and of P, the r.m.s. value of the variable component of the wind pressure at the centre of the storm; for the idealized storm considered, and for $r/D \gg 1$, this is approximated by $H^2 = 10P^2D^2/rL$, all quantities being in centimetres, including P, which is measured in centimetres on a water barometer. Comparison with data for an actual storm indicates that this theory requires a value of P that is possibly 10 times greater than its actual value. While the theory explains many of the phenomena of storm waves, it is therefore incapable of accounting quantitatively for the wave height. The possible reasons for this inadequacy are

discussed. The relation of the theory to Jeffreys' sheltering theory is also discussed, and it is shown that both postulate that the variable component of the wind stress is normal to the water surface. The sheltering theory also postulates that the wind pressure lags 90° behind the surface disturbance. A similar phase lag is a consequence of the assumptions of the present theory. A.

CAPILLARITY 532.6

532.61

2076. Shapes of floating liquid zones between solid rods. P. H. Keck, M. Green and M. L. Polk. *J. appl. Phys.*, **24**, 1479–81 (*Dec.*, 1953).

Aims at describing the shapes of liquid floating zones between solid rods of silicon and of germanium and to discuss stability conditions. The shapes were deduced from the equation given by Laplace, $p = \gamma(1/R_1 + 1/R_2)$, where p indicates the pressure difference across the surface membrane of a liquid at any point, R_1 and R_2 are the principal radii of curvature at that point, and γ is the surface tension of the liquid. The floating liquid zone is analysed within a wide stability range. Its dimensions were theoretically determined and experimentally confirmed. A.

532.612

2077. Surface tensions of solutions of cationic surface-active agents. C. Paparoditis and J. Guastalla. *C.R. Acad. Sci.* [*Paris*] **237**, 977–9 (*Oct.* 28, 1953) *In French.*

The method of a suspended plate for measuring surface tension gives anomalous results when it is used for solutions of certain cationic long chain compounds. This is due to the fact that these substances tend to make the plate hydrophobic. Correct values for surface tension can be obtained using a method developed originally by Matalon [Abstr. 1026 (1947)]. In this a stirrup is pulled out of the surface and the curve relating the force against height is drawn. The slope (P) of the curve at the origin is related to the surface tension (γ) by the expression $P = 2\gamma\rho g$, where ρ = density. An application of the method is described. J. IBALL

532.612 : 537.22

2078. Dielectric potentials and surface tensions of solutions of wetting substances. B. Kamienski and J. Machaczka. *Bull. internat. Acad. Polon. Sci. A, No.* 7–10, 411–16 (*July–Dec.*, 1951).

Surface potentials and surface tensions are measured of solutions of several commercial aerosols (1B, A7, MA and OT). The solvent was an aqueous solution of KCl and the effects of pH, concentration of KCl, respectively, were investigated. J. IBALL

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

2079. The theory of monatomic liquids. J. de Boer. *Nuovo Cimento*, **10**, *Suppl. No.* 3, 225–50 (1953) *In French.*

A review of various attempts at the theory of the liquid state. The statistical mechanics and the radial distribution function are discussed as well as the quasicrystalline theory of liquids. The inadequacy of all these is indicated. T. C. TOYE

532.7

2080. Molecular diameter of a liquid. M. G. Bhatawdekar. *Indian J. Phys.*, **27**, 145–8 (*March*, 1953).

Knowing the potential energy of a liquid, an idea is gained about the diameter of the constituent molecules. The pressure within liquid carbon dioxide and ethyl alcohol at different temperatures is calculated; for the former, change in free energy and internal energy is also calculated. A.

532.7 : 533.7 : 537.531 : 535.42 : 537.533.73

2081. On measurements of interatomic distances in gases and liquids by electron and X-ray diffraction methods. H. Viervoll. *Trans Instrum. Meas. Conf.*, **1952**, 64–72.

Gives the theoretical basis and experimental procedures, with examples of their application to various structure investigations. J. THEWLIS

532.7 : 536.7

2082. Thermodynamics of solutions of volatile solids. R. P. Rastogi. Letter in *Curr. Sci.*, **22**, 301–2 (*Oct.*, 1953).

A generalized Clausius–Clapeyron equation for solutions of non-electrolytes has been obtained; this is applicable to binary ideal liquid mixtures and also to solid solutions of volatile solids. Good agreement between theory and experiment is shown by the data for the system borneol-camphor. It is stated that β-naphthol-naphthalene shows similar agreement. The theory has also been applied to study the boiling-point elevation of solutions of volatile solutes. Assuming the solutions obey Raoult's law the results for carbon-disulphide/camphor show satisfactory agreement with theory. Similar agreement is observed for carbon-disulphide/naphthalene. F. E. HOARE

532.71

2083. On Isihara–Hayashida's theory of the second virial coefficient for rigid convex molecules. T. Kihara. Note in *J. Phys. Soc. Japan*, **8**, 686–7 (*Oct.*, 1953).

Some corrections of errors in the earlier calculations [see Abstr. 6067–8 (1951)]; new f-values for some regular polyhedra and other simple bodies are reported. J. JACOBS

532.73

2084. Diffraction of X-rays in aqueous solutions of formaldehyde. F. Cennamo and E. Tartaglione. *Nuovo Cimento*, **10**, 1012–17 (*Aug.*, 1953) *In Italian.*

Experimental diffraction curves are given, and it is deduced that the characteristic groups of both the solvent and the solute are present in the solutions. A.

532.73

2085. On the microfriction in liquids. A. Spernol and K. Wirtz. *Z. Naturforsch.*, **8a**, 522–32 (*Sept.*, 1953) *In German.*

A study of solutions of various types of molecule

show that the Stokes formula for a spherical body can be modified by the introduction of a "microfriction" factor which is unity for large radii. An empirical value of this factor is shown to depend upon the radius ratio of the solute and solvent molecules. T. C. TOYE

532.73

2086. Molecular theory of microfriction. A. GIERER AND K. WIRTZ. *Z. Naturforsch.*, **8a**, 532–8 (*Sept.*, 1953) *In German.*

532.74 : 537.311.35

A model of metal-ammonia solutions. *See Abstr.* 2437

532.74 : 541.132

2087. X-ray diffraction and electrolytic dissociation. P. N. SHARMA, S. N. DUTTA AND S. R. BHATTACHARYA. Letter in *Curr. Sci.*, **22**, 201 (*July*, 1953).

X-ray diffraction patterns were obtained of aqueous solutions of $NaHSO_4$ over practically the whole range of concentrations, as well as of the solid powder, with the use of Cu K_α radiation. At high concentration the $NaHSO_4$ causes a ring on the photograph separate from the water ring. This becomes diffuse at higher dilution and reappears again in very diluted solutions. The disappearance of the ring can be explained by the rearrangement of the water molecules in the electric field of the ions, the reappearance by the second stage dissociation of the $NaHSO_4$ molecule. A. J. TAYLOR

532.785 : 548.5

2088. Study of the concentration of the solution around a crystal in course of growth. S. GOLDSZTAUB AND R. KERN. *Acta cryst.*, **6**, 842–5 (*Nov.*, 1953) *In French.*

The experiments of Berg, Bunn and Humphreys-Owen on the concentration of the solute in the vicinity of a growing crystal have been repeated as part of a series of investigations on the relation between habit and supersaturation. With an interferometric method using polarized white light (Françon) the results of these authors could not be confirmed. The curves of equal concentration close to the faces are parallel to the faces. In rapid growth the concentration gradient is greater at the crystal edges than above the face interiors, a fact which explains the transport of solute to these points and the occurrence of dendritic growth. A.

MECHANICS OF GASES 533

533.16

2089. The viscosity of hydrogen and deuterium at pressures up to 2000 atmospheres. A. MICHELS, A. C. J. SCHIPPER AND W. H. RINTOUL. *Physica*, **19**, 1011–28 (*Oct.*, 1953).

The viscosity was measured by a transpiration method at temperatures between 25°C and 125°C at pressures up to 2000 atm. The results are compared with the theoretical values obtained from the formulae of Enskog for dense gases. A.

533.275 : 621.317.79

2090. Electric hygrometer of small dimensions. W. A. BRASTAD AND L. F. BORCHARDT. *Rev. sci. Instrum.*, **24**, 1143–4 (*Dec.*, 1953).

An electric hygrometer of the Dunmore type has been constructed so reduced in size as to fit inside the end of a hypodermic needle. A special indicating circuit is required because of the small current permissible across the hygroscopic film. Relative humidities associated with surfaces as small as 0·001 in.^{2} have been measured. A.

533.5

2091. On the large load characteristics of vapour pumps. S. K. MUKHERJEE AND P. K. DUTT. *Indian J. Phys.*, **27**, 137–44 (*March*, 1953).

The different characteristics of vapour pumps under various leak-load and forepressure conditions are studied. The leak-load position dependence of forepressure is investigated from which different conditions of critical forepressure are distinguished. A.

533.5

2092. Note concerning the detection of leaks by means of a Pirani gauge. T. REIS. *Cahiers de Phys.*, *No.* 46, 59–62 (*Nov.*, 1953) *In French.*

The use of a Pirani gauge as a manometer for evacuated systems is based on the change in temperature of a heated metal filament, which varies with the pressure and the thermal conductivity of the surrounding gas. The gauge can be calibrated, for a given gas, by introducing the gas into the system through an artificial leak. Hydrogen, owing to its high thermal conductivity, was found to be most suitable. Details of apparatus, calibration and two examples of leak detection at different pressures, are given. G. WITTENBERG

533.5 : 518.5

2093. Further applications of the electrical analogue to vacuum systems. D. W. STOPS. Note in *Brit. J. appl. Phys.*, **4**, 350 (*Nov.*, 1953).

The representation of a vacuum system operating under free molecular gas flow conditions by an RC circuit with various sources of e.m.f.'s or currents is discussed. Variations of voltage with time are analogous to those of pressure with time, and the current corresponds to the throughput through a leak. The analogue may be used for determining the effect of inserting pumps in the vacuum line, for simulating the sudden evolution of known quantities of gas or vapour, and for finding the response of the system to mixtures of gases and/or vapours. G. WITTENBERG

533.56

2094. The theory of high-speed oil diffusion pumps. L. RIDDIFORD AND R. F. COE. *J. sci. Instrum.*, **31**, 33–6 (*Feb.*, 1954).

The importance of vapour density in the jets of high-speed oil diffusion pumps is stressed. It may be low, firstly, on account of the pressure gradient in the tower up which the vapour is fed from the base of the pump, and secondly, because of the radial spreading of the jet after it leaves the tower. By means of a first-order theory it is shown that for greatest speed there is an optimum diameter for the central tower. The shape of the theoretical curve fits the experimental points very well. The difficulty of obtaining high speeds with hydrogen is discussed. A.

533.59

2095. The sources of electron-induced contamination in kinetic vacuum systems. A. E. Ennos. *Brit. J. appl. Phys.*, **5**, 27–31 (*Jan.*, 1954).

The relative importance as contaminants of various materials which are used in the construction of kinetic vacuum systems was assessed by introducing them into a clean system and measuring the carbonaceous deposit formed on a surface bombarded by electrons. In order of descending contaminating power are diffusion pump oil (hydrocarbon), vacuum grease, various types of rubber gasket material, silicone pump oil, and vacuum wax. Uncleaned metal surfaces are also a considerable source of contamination, and methods of cleaning are discussed. Experiments carried out on the dependence of contamination rate upon the temperature of the bombarded surface showed that a 10 times reduction could be expected from raising the temperature to 200°c. A cold trap at −15°c, surrounding it, was found to be equally effective. A.

533.6.011 : 536.244

2096. Mathematical theory of the flow of a gas in a porous solid and of the associated temperature distributions. D. R. Bland. *Proc. Roy. Soc. A*, **221**, 1–28 (*Jan.* 7, 1954).

This paper considers the flow of a gas through a porous solid, when temperature differences exist between gas and solid and heat is exchanged between them. It attempts to determine the velocity and both temperature distributions, all of which in general are interdependent, in the general case of three independent space variables and of one time variable. It postulates both a simple heat-transfer equation suggested by an experimental paper and a generalization of Darcy's law, which states that the velocity of flow of the gas is proportional to the pressure gradient. In addition, it makes use of the perfect gas and continuity equations. The heat-transfer equations are deduced. Some special cases are solved explicitly. In general, a numerical solution is necessary, and an example of such a solution is given for steady axisymmetric flow. A case of linear flow with the variables periodic in time is solved analytically. Two applications of this theory are "sweat cooling," which is used in gas turbines, and the design of heat exchangers. A.

533.6.011 : 537.533.7

2097. Electron shadowgraphs and afterglow pictures of gas jets at low densities. A. E. Grün, E. Schopper and B. Schumacher. Letter in *J. appl. Phys.*, **24**, 1527–8 (*Dec.*, 1953).

Two methods are described for studying visually the behaviour of gas jets especially in the low-pressure region where the usual optical methods fail. In the first method, a parallel beam of relatively low-energy electrons is projected into the gas; the resulting scattering and absorption spreads the beam and this brightens a suitably placed glass screen when it impinges on it. Local variations in the density of the gas in the jet appear as shadows on the screen. In the second method, a well-focused beam of high-energy electrons traverses the jet and excites a small volume of the gas. If the gas has a long afterglow, the jet becomes visible over a certain length of its path. Two photographs illustrate the methods. See also Abstr. 4830 (1953). H. J. H. Starks

533.6.011 : 539.217.1

2098. Effect of gas slip on unsteady flow of gas through porous media. J. S. Aronofsky. *J. appl. Phys.*, **25**, 48–54 (*Jan.*, 1954).

A numerical method is presented for describing either the one-dimensional or radial transient flow of gases through a porous medium in which the initial and terminal pressures and/or rates are specified. The purpose of this investigation was to evaluate the effect on transient gas flow of a pressure-sensitive gas permeability resulting from gas-slip effects. The gas-slip permeability or apparent permeability is assumed to vary as a linear function with the reciprocal pressure. The computations were carried out by means of punch card machines. The results demonstrate that under certain conditions, the transient flow system is greatly influenced by gas-slip permeability. However, the results also indicate that the effect of gas-slip on transient flow behaviour is negligible for pressure conditions usually associated with gas or petroleum reservoirs, and would be of most importance in the conduct and analysis of gas flow experiments in the laboratory. A specific laboratory application of the calculations is a possible transient method for the determination of porosity and/or gas-slip corrected permeability. A.

533.6.011.3 : 534.141.4

On edge tones and associated phenomena. *See Abstr.* 2109

533.6.011.5

2099. Supersonic gas flow. W. A. Mair. *Brit. J. appl. Phys.*, **5**, 1–6 (*Jan.*, 1954).

An introductory review, with emphasis on the features that distinguish supersonic from subsonic flow. Experimental methods for the study of supersonic flow are briefly considered and some simple flows are described. A.

533.6.07/.08

2100. On measuring low level turbulence (in aerodynamics). H. Schuh. *Trans Instrum. Meas. Conf.*, **1952**, 277–80.

Intensity of turbulence is defined as the ratio of the average velocity fluctuations in the stream to the mean speed; intensities of turbulence ranging from 0·5–0·01% are important in connection with "slow turbulence" wind-tunnels. A closed circuit "low turbulence" wind tunnel having a contraction ratio 30 : 1, in place of the normal 5 : 1, is illustrated. Mechanical and electrical difficulties encountered when measuring turbulence in wind tunnels by the customary use of a hot-wire anemometer are briefly discussed. Vibrations of the wire holder are eliminated by a design in which the resonant frequencies of its parts, and more especially the wire-holding needles, are outside the frequency range transmitted. Vibrations of the wire support are avoided by using a very rigid structure. Mechanical vibrations of the electronic valve system used for amplifying voltage fluctuations are avoided by selecting valve types designed for low microphony and housing the entire

alve system in a steel sealed box suspended on soft ubber bands. A suitable design of wire holder for neasuring very low turbulence levels is described and lustrated. The lowest intensities of turbulence neasured with the equipment was about 0·005% at 0 m sec, 0·01% at 40 m sec, and 0·02% at 100 m sec, or the longitudinal component; for the lateral component the intensities measured were somewhat igher, viz. 0·01–0·03%. J. S. G. THOMAS

533.6.07

2101. The Toepler schlieren apparatus. D. W. HOLDER AND R. J. NORTH. *Aeronaut. Res. Coun. Min. of Supply) Rep. Mem. No.* 2780, 13 *pp.* (*April*, 1950).

For wind-tunnel observations it is usually necessary hat a Toepler schlieren apparatus shall have roughly uniform sensitivity to density gradients within a certain range determined by the nature of the flow. It is also desirable that the illumination in the image of the flow shall be as high as possible if visual observations are to be made under the best conditions and if photographs are to be taken with very short exposures. Methods for satisfying these two requirements are discussed and experimental results are included to illustrate their importance.

533.6.08 : 536.532

2102. Response of two-material laminated cylinder to simple harmonic environment temperature change. H. H. LOWELL. *J. appl. Phys.*, **24**, 1473–8 (*Dec.*, 1953).

In current aeronautical research, rapidly-responding thermocouples and hot-wire anemometers are required. The use of oxide cylinders coated with more or less thin layers of metal effects substantial improvements in rates of instrument response. The theory and results of numerical calculations for six typical situations are given. It is shown that for ratios of metal thickness to over-all radius of 0·1, response amplitude gains of the order of 4 or 5 are to be expected as compared with typical gains of the order of 10 or more for infinitesimal shells (surface layers). A.

MOLECULAR THEORY OF GASES 533.7

533.7 : 537.531 : 535.42 : 537.533.73 : 532.7

On measurements of interatomic distances in gases and liquids by electron and X-ray diffraction methods. *See Abstr.* 2081

VIBRATIONS . ACOUSTICS 534

534.014.5

2103. On interaction of non-linear oscillations. N. MINORSKY. *J. Franklin Inst.*, **256**, 147–66 (*Aug.*, 1953).

In Pt I some general considerations regarding the existence, stability and certain topological rules of selection between several oscillations are outlined. In Pt II these results are applied to the differential equation $\ddot{x} + e(x^2 - 1)\dot{x} + [1 + (a - cx^2)\cos 2t]x = 0$, investigated by the stroboscopic method as far as the first approximation is concerned. The problem of interaction of oscillations is studied in the general case and in some special cases. A.

534.121.1

2104. Concerning combined and degenerate vibrations of plates. M. D. WALLER. *Acustica*, **3**, *No.* 6, 370–4 (1953).

The distinction between "combined single" and "combined normal" vibrations of elastic plates is discussed, and also the two uses which are made of the latter term. The modes of vibration with equal characteristic frequencies of square and regular triangular plates do not combine because they belong to different classes of symmetry. All the possible vibrations of a plate of geometrical shape must be "mechanically balanced" about one or more lines of symmetry, and the additional "degenerate" vibrations which are predicted by the mathematical theory are impossible. A "coupling by symmetry" which has been observed with rectangular plates is described. A.

534.121.1 : 537.228.1

Thickness-shear and flexural vibrations of crystal plates. *See Abstr.* 2412–4

534.13

2105. Dynamics of the elastic vibration in a bar excited by longitudinal impact. II. Study of the time of collision. M. GHOSH AND S. K. GHOSH. *Indian J. Phys.*, **26**, 463–71 (*Sept.*, 1952).

For Pt 1, see Abstr. 9340 (1951). Expressions for the time of collision using both hard and elastic load are derived when the impact terminates during the first and second intervals and the possibility of deriving the same for higher interval is discussed. The pressure fluctuation during the collision period is studied and compared graphically for a fairly wide range of values of the elastic constant of the load. The variation of the time of collision with elasticity of the load is thoroughly studied. It is found that with the increase of elasticity of the load the time of collision changes discontinuously until gradually the discontinuities become less and less pronounced as the hardness is reached. It is also observed that the time of collision in the case of a hard load changes discontinuously with the length of the bar, i.e., with the change of "mass-ratio" of the bar and the load. A.

534.13 : 534.44

2106. Theoretical studies of vibratory movements with obstacles and discontinuities. J. GUITTARD. *Acustica*, **3**, *No.* 1, 22–32 (1953) *In French.*

Special types of vibratory movement with obstacles or discontinuities can be analysed by the powder method or by manometric capsules and are susceptible to mathematical representation. Of this type are non-periodic circulations and vortex phenomena, to which may be added Kundt's striations. The stream lines can be derived from complex potentials and conformal representation in a two-dimensional space. The study of a junction (Y tube) shows also the necessity of making hypotheses concerning the successive reflections and attenuation of the sound waves, having regard to which the experimental results can be well satisfied. A.

534.138

2107. The response of a spherical fluid particle suspended in air to irradiation with sound at the natural frequency of the particle. T. G. HODGKINSON. *Acustica*, **3**, *No.* 6, 383–90 (1953).

A spherical drop of liquid is considered as suspended in a gaseous medium, and as irradiated with a sound wave, a component frequency of which compares with a natural frequency of the spherical drop. Emphasis is placed upon the second mode, as the first distortional mode of vibration of the drop, and for this mode, the particle velocity on the surface of the drop is determined as a function of the densities and viscosities of the liquid and the gas, of the surface tension of the gas-liquid surface, and of the velocity potential of the component frequency of the irradiating wave. It is shown that for very large drop sizes, the particle velocity in the incident wave, required to produce stress in the surface of the drop comparing with the surface tension of the liquid-gas surface, is almost independent of the value of this surface tension. Examples are calculated of the field energy required for an 130 μm diameter particle and for an 800 μm particle at their natural frequencies in the second mode, and comparison is made with the energy available in the sound field of a particular siren. A.

534.141.3

2108. Investigation on the bowed string with an electrically driven bow. II. N. K. DATTA. *Indian J. Phys.*, **26**, 577–84 (*Dec.*, 1952).

This verifies a part of the formula established in Pt I [Abstr. 5611 (1952)]. The values of $\alpha\mu_d$, where μ_d is the dynamical coefficient of friction during backward motion and α, a constant factor, have been obtained with different specimens of metal wires and with different diameters of the same metal wire. The variation of $\alpha\mu_d$ with bowing distance d for different diameters of the wires and for different materials was studied. The paper indicates why gut and fine steel strings are generally used in violin. In all the different cases studied, it was found that the zero-point is always at some distance from the mid-point of the bowed region. This explains why $P_{min} \times d$ was found to be only approximately constant in Pt I. For a given bowing velocity the distance (x) of the zero-point from the mid-point of the bowed region was calculated for all the wires and was found to increase with bowing distance for metallic wires, but to decrease in the case of gut. A.

534.141.4 : 533.6.011.3

2109. On edge tones and associated phenomena. A. POWELL. *Acustica*, **3**, *No.* 4, 233–43 (1953).

The edge tone phenomena occurring at high jet speeds have been photographed by the schlieren method and the sound waves made clearly visible. They are of opposite phase on each side of the stream, and microphone traverses have shown this to be the case at low speeds also. This observation makes possible an explanation of the mechanism whereby the sound waves give rise to stream disturbances at the jet orifice. Two basic relationships are given, one connecting the relative phases of the motion and the other dealing with the effective efficiencies of each of the component processes. Although an exact theoretical solution is not yet possible, certain assumptions with regard to disturbance velocity result in good agreement with experiment, after invoking the condition that the jet shall operate near the region of maximum sensitivity. It is pointed out that the lower frequency limit of the sensitivity arises from an insufficiently large rate of amplification of stream disturbance, whereas the upper limit is the result of a trend towards stability. The general theory is capable of explaining the jumps of frequency, associated hysteresis effects and other characteristics. The observed susceptibility to local reflectors or resonators is discussed, and it is suggested that an extension to other phenomena, for example the organ pipe, could be made. A.

534.151 : 534.41

2110. Analysis of vibratory movements in a sounding pipe. Discontinuities in the centre. J. GUITTARD. *Acustica*, **2**, *No.* 5, 231–6 (1952) *In French.*

This is a method of analysis of the vibratory movement of the air in a sounding pipe or other closed cavity, by means of fine dust. The method may be applied on the one hand to derivations, section variations or other deformations of the cylindrical column, on the other hand to phenomena of circulation and vortex production in the pipe by small obstacles. A.

534.154

2111. Experimental investigation of the vibration of railway tracks. H.-J. NAAKE. *Acustica*, **3**, 139–47 (1953) [=*Akust. Beih.*, *No.* 1 (1953)] *In German.*

The vibrations of rails have been investigated under different conditions: measurements have been made with sinusoidal excitation of rail lengths suspended by steel wires, on a test track 7 m long, and on a ready-laid track; in addition the vibrations excited in a rail by a train moving along the track have been measured. For the rail suspended by steel wires, the measurements gave the curve of the phase velocity against frequency for all sorts of vibrations present up to a frequency of 10 kc/s. At the test track and at the ready-laid track, the measurements have been extended over the frequency-range from 200 c/s to 80 kc/s. From the measurements of the noise caused by the moving train, the value of the acceleration and the frequency spectrum of the rail vibrations have been calculated. A.

534.21

2112. Remarks on the concept of acoustic energy. A. SCHOCH. *Acustica*, **3**, *No.* 3, 181–4 (1953).

The conventional expressions for acoustic energy—recently found not to be correct in a strict sense—are shown to have characteristic properties by which their use in acoustics can be justified satisfactorily. A.

534.21

2113. On a variational principle in acoustics. O. K. MAWARDI. *Acustica*, **3**, *No.* 3, 187–91 (1953).

Describes an investigation of the propagation of sound inside an acoustic labyrinth. The latter consists of a tube of rectangular cross-section interrupted at periodic intervals by thin partitions with staggered openings. By virtue of the expected

periodicity of the wave function in the labyrinth, Floquet's theorem can be employed to determine the velocity potential anywhere in the structure as a function of the potential in the space between any two consecutive partitions. This property is used in developing a variational principle which yields the propagation constant of acoustic waves travelling down the labyrinth. The phase velocity and attenuation for the simpler type of waves propagated have been evaluated by the principle. The accuracy of the method is believed to be quite satisfactory. A.

534.21

2114. Theory of the damping of air-borne sound in a rectangular tube with absorbing wall, and the highest attenuation constant obtainable with it. L. CREMER. *Acustica*, **3**, 249–63 (1953) [=*Akust. Beih.*, *No.* 2 (1953)] *In German.*

The attenuation constant is calculated for the sound propagation in a rectangular tube containing one absorbing wall of impedance $\overline{W}$. At first the sound pressure is assumed to be constant across the cross-section of the tube. Results of this one-dimensional calculation which holds for lower frequencies and higher wall impedances are summarized in a graph. Taking into account the variation of sound pressure perpendicular to the axis of the tube leads to the diagram of Morse which, however, furnishes only preliminary quantities from which the attenuation constant must be calculated for a given frequency. From this diagram five charts are derived from which (for five different frequencies) the attenuation constant can be read directly. These charts show that the highest attenuation is obtained when the wall impedance is $\overline{W} = 1{\cdot}2\,e^{-0{\cdot}7i}\rho c(2h/\lambda)$ (ρc = characteristic impedance in air, λ = wavelength, h = width of tube perpendicular to the absorbing surface). With this wall impedance the decrease of level per unit width of the tube is 19 dB for lower and $3{\cdot}5\,\lambda/h$ dB for higher frequencies. A.

534.21

2115. Experimental investigation of the attainment of the highest theoretically possible attenuation of sound propagation in a rectangular air duct with absorbing walls. O. GERBER. *Acustica*, **3**, 264–70 (1953) [=*Akust. Beih.*, *No.* 2 (1953)] *In German.*

An apparatus is described for measuring the attenuation constant of a narrow, rectangular tube, one wall of which is absorbent. The absrobing wall consisted of homogeneous layers of sound-absorbing material of small flow resistance interrupted by partition walls. With suitably chosen flow resistance and a tube width of 5 cm attenuation constants of 170 to 200 dB/m could be obtained for certain frequencies. Furthermore, wall impedances are described which produce a mean value of attenuation of 60 dB/m in a wide frequency range. A.

534.21

2116. Measurement of sound propagation in liquid-filled tubes with resilient walls. W. KUHL AND K. TAMM. *Acustica*, **3**, 303–16 (1953) [=*Akust. Beih.*, *No.* 2 (1953)] *In German.*

In cylindrical columns of liquid the propagation of various modes of waves is possible (differing by their sound distribution over the cross-section) and these have different propagation constants. All modes of waves have a lower cut-off frequency below which no propagation but only an exponential decay is observed, except the "quasi plane" mode. The latter mode only occurs if the boundaries of the liquid are rigid or represent a compliance. Liquid-filled tubes, the walls of which behave like a mass impedance or have zero impedance, therefore allow no sound propagation at all below the lowest cut-off frequency. In good agreement with a theoretical treatment of columns with rectangular and circular cross-sections (as well as for subdivided circular cross-sections) it is shown from a number of experiments that the suppression of sound propagation can be realized by lining tubes with resilient material (cell rubber). A.

534.21 : 533.6.011

2117. Movement of air past obstacles in a sound-field, studied by means of smoke particles. I–III. N. SKOGEN. *K. Norske. Vidensk. Selsk. Forhandl.*, **24**, *No.* 12–14, 60–71 (1951).

The movement of air around various obstacles in a sound field is made visible by means of smoke particles, employing a method used by E. N. da C. Andrade [*Proc. Roy. Soc.*, **134**, 445 (1932)]. In Pt I, the motion of the air around a thin rectangular plate is observed. Two kinds of circulation were found, depending on the position of the plate (*a*) when the plate is parallel to the direction of the sound a circulation arises with air leaving the plate parallel to the direction of the sound, and (*b*) when the plate is normal to the direction of sound a circulation arises with air leaving the plate normal to the direction of sound. Pt II deals with the more complex motion in the neighbourhood of a circular hole in a screen normal to the direction of sound. It shows that the various types of circulation which may occur may be reduced to the two types described in Pt I. Pt III describes the air motion occurring around a circular cylinder—an "inner" and an "outer" circulation system being observed. A. B. WOOD

534.21 : 535.41

2118. An acoustic interferometer for high fluid pressure. H. D. PARBROOK. *Acustica*, **3**, *No.* 2, 49–54 (1953).

An acoustic interferometer for high fluid pressures is described. Some of the problems of ensuring a plane uniform field are discussed. A method is given for indicating the efficiency of crystal holders, and comment is made on some frequently recommended holders. A.

534.21 : 539.32

The determination of the elastic constants of isotropic rigid bodies by ultrasound. *See Abstr.* 2790

534.21 : 541.182.2

2119. The acoustic properties of gas bubble mists in water. E. MEYER AND E. SKUDRZYK. *Acustica*, **3**, 434–40 (1953) [=*Akust. Beih.*, *No.* 3 (1953)] *In German.*

On the basis of the known properties of pulsating gas bubbles in water (resonance-frequencies and damping factors) formulae are derived for the complex compressibility and therewith for the phase velocity and attenuation of sound waves in water containing

gas bubbles. Numerical computations are made for two cases: for a bubble mixture of constant bubble size and of one with a continuous distribution of bubble size with equal volume concentration. In a big tank bubble-water mixtures were produced in three different ways: by pressing air through porous plates, by electrolysis, and by means of a pumping device. In these mixtures of bubbles and water phase velocity and sound attenuation were measured in a wide frequency range. The results agree as well with theory as can be expected. A.

534.21 : 551.556

2120. The attenuation of sound propagated over the ground. J. D. HAYHURST. *Acustica*, **3**, *No.* 4, 227–32 (1953).

Theoretical calculations by Knudsen, supported by the results of laboratory experiments, have established the attenuation of sound in still air. Little work has hitherto been done out-of-doors because of the difficulty of making allowances for the effect of wind on the attenuation. In the course of an aircraft noise abatement investigation made recently by the Ministry of Civil Aviation, the effect of wind on the propagation of sound over a dry concrete runway has been explored up to a distance of about half a mile from a source of sound. It was found that the only significant parameter was the component of wind in the direction of propagation and the values that emerged showed that wind effects cannot be neglected in any acoustic work made out-of-doors. By interpolation the attenuations corresponding to a zero wind component in the direction of propagation were derived and were found to be substantially greater than those previously determined for still air. The attenuations were, however, statistically independent of the absolute wind speed. Repetition of the investigation but over grassed areas produced no reliable results. A.

534.22/.23

2121. On the use of ultrasonics as a means of structural investigation. P. G. BORDONI. *Nuovo Cimento*, **10**, *Suppl. No.* 3, 251–9 (1953) *In Italian.*

The experimental methods and results obtained by various investigators for the measurement of the velocity and attenuation of ultrasonics in gases, liquids and solids are briefly reviewed and the information which such measurements can provide concerning the structure of the medium is indicated.

S. WEINTROUB

534.22/.23

2122. The velocity and absorption of sound in aqueous sugar solutions. A. W. PRYOR AND R. ROSCOE. *Proc. Phys. Soc.* [*London*] *B*, **67**, 70–81 (*Jan.*, 1954).

Measurements of the absorption of sound were made by a pulse method due to Pinkerton, and measurements of the velocity by a pulse-interference method, in the frequency range 6 to 25 Mc/s. Solutions of sucrose, d-glucose and lactose were investigated at various concentrations and temperatures. The velocity results confirm the conclusion, originally derived from viscosity measurements, that the sugar molecules have "solvation envelopes" (attached layers of water molecules) which decrease in thickness as the temperature of the solution rises. The ratio of the actual absorption to the "classical" absorption is found to be fairly close to the value of this ratio for water (3·1) at all concentrations, while elementary considerations suggest that it should decrease towards unity as the concentration increases. A theoretical treatment reveals, however, an additional source of energy dissipation at high concentrations which approximately accounts for the constancy of this ratio. This dissipation arises from the high local viscous stresses which result from the squeezing-out of water molecules from between the sugar molecules when the solution is compressed. Similar considerations must apply to pure associated liquids if these contain two different states of molecular arrangement, one crystalline and one disordered. On this account a value of about 2·25 for the ratio of actual to classical absorption is to be expected for such liquids, while the observed values for alcohols and water range from 1·64 to 3·10. Some doubt is thus cast upon the theory that the major part of the absorption in water is due to a structural relaxation process. A.

534.22

2123. Sound velocity measurements in organic liquids. S. PARTHASARATHY AND N. N. BAKHSHI. *Indian J. Phys.*, **27**, 73–6 (*Feb.*, 1953).

Measurements were determined in 48 organic compounds of various molecular structures with a view to checking previous results. Rules obtained previously regarding the relation between sound velocity and chemical constitution have been applied to them and are found to hold good. A.

534.222 : 534.614

2124. The velocity of sound in air. J. M. A. LENIHAN. *Acustica*, **2**, *No.* 5, 205–12 (1952).

Measurements have been made of the velocity of sound in free air at a frequency of 13 500 c/s. A small loudspeaker, connected to an oscillator, emitted sound which, after travelling a distance determined by an accurate screw, was received by a microphone. The input waveform of the transmitter and the output waveform of the receiver were passed through pulse-shaping circuits and displayed together on the screen of a double beam oscillograph. Movement of the transmitter, controlled by rotation of the screw, produced relative motion of the two traces on the oscillograph screen and the wavelength of the sound was determined by measuring the distance between successive positions of the transmitter at which the two trains of pulses coincided on the screen. Corrections were applied for the effects of temperature, humidity and a number of less important factors. The final value for the velocity of sound at a frequency of 13 500 c/s in dry air at a temperature of 273·16°K and a pressure of 1013·2 mb was 331·45 ± 0·04 m/s. A.

534.222.2

2125. Cylindrical shock waves produced by instantaneous energy release. S.-C. LIN. *J. appl. Phys.*, **25**, 54–8 (*Jan.*, 1954).

Taylor's analysis of the intense spherical explosion has been extended to the cylindrical case. It is found that the radius R of a strong cylindrical shock wave produced by a sudden release of energy E per unit length grows with time t according to the equation

$R = S(\gamma)(E/\rho_0)^{1/4}t^{1/2}$, where ρ_0 is the atmospheric density and $S(\gamma)$ is a calculated function of the specific heat ratio γ. For $\gamma = 1{\cdot}4$, $S(\gamma)$ is found to be approximately unity. For this case, the pressure p_1 behind the shock wave decays with radius R according to the relation $p_1 = 0{\cdot}216E/R^2$. Applying the results of this analysis to the case of hypersonic flight, it can be shown that the shock envelope behind a meteor or a high speed missile is approximately a paraboloid given by $R = (D/\rho_0)^{1/4}(x/V)^{1/2}$ where D and V denote the total drag and the velocity of the missile, respectively, and x is the distance behind the missile. A.

534.222.2

2126. Velocity attenuation of explosive-produced air shocks. J. Savitt and R. H. F. Stresau. *J. appl. Phys.*, **25**, 89–91 (*Jan.*, 1954).

A method for measuring the velocities of explosive-produced air shocks using an electrical ionization probing system is described. The results of such measurements indicate that under varying conditions of confinement of explosive and air shock, that the reciprocal of the air shock velocity varies linearly with the distance to the charge surface. A.

534.23

2127. Sound transmission in human bones. F. Seidl. *Acustica*, **3**, *No.* 4, 224–6 (1953) *In German.*

The absorption and reflection of sound incident on human bones is made visible by means of schlieren methods. Using a prism device, the velocity of sound in bone is measured. A.

534.23

2128. Transmission of sound through plates. K. R. Makinson. Letter in *J. Acoust. Soc. Amer.*, **25**, 1202 (*Nov.*, 1953).

Fay's treatment of the theoretical problem of the transmission of sound through a solid plate immersed in a fluid is used to deduce an additional criterion for total reflection, and some comments are made on the criteria for total transmission. A.

534.23

2129. Measurements of sound absorption in water and in aqueous solutions of electrolytes. G. Kurtze and K. Tamm. *Acustica*, **3**, *No.* 1, 33–48 (1953).

By means of four types of apparatus, working in successive frequency ranges, absorption measurements were made in the large frequency range 4×10^3 to 10^8 c/s. For the lowest frequencies (4–50 kc/s) the absorption was determined from the decay of single normal modes of oscillation of a spherical vessel, filled with the solution. In the medium range (50–1000 kc/s) a reverberation method was applied. Above 1 Mc/s the attenuation of progressive waves was measured with the optical method, using two different techniques (3–15 Mc/s and 20–100 Mc/s). The measurements in water yield a value $\alpha/\nu^2 = 25\times10^{-15}$ s^2/m at 20°c, independent of frequency down to 100 kc/s. The experimental results with electrolytes permit a number of fundamental conclusions with respect to the dependence of the absorption on frequency, on concentration, temperature and pH-value of the solutions and on the properties of the ions such as valency and ion radius. The results indicate relaxation processes. As an attempt at interpretation, four models are discussed: (1) excitation of molecular degrees of freedom, (2) hydration of the ions, (3) formation of ion associates, and (4) hydrolysis, the latter being the most probable one. A.

534.23

2130. The attenuation of the higher modes of acoustic waves in a rectangular tube. E. A. G. Shaw. *Acustica*, **3**, *No.* 2, 87–95 (1953).

Kirchhoff's theoretical treatment of plane wave propagation in a cylindrical tube, allowing for the finite viscosity and thermal conductivity of the gaseous medium, has been applied to the higher-order modes of waves between a pair of parallel infinite planes; the more general case of the rectangular tube requires a boundary layer approach. The attenuation of (1, 0) waves has been accurately measured in the 2·4 to 3·0 kc/s region using a new probe microphone technique to explore a system of standing waves in a rectangular tube. Under suitable experimental conditions the observed and theoretical values of attenuation constant are in agreement within 2%. In contrast with the plane wave case, the ratio of viscous to thermal conduction losses for higher-order mode waves is not constant but depends on the frequency and geometrical configuration of the waves. It is suggested, therefore, that measurements of the absorption of such waves may provide a new method of determining both the shear viscosity and thermal conductivity coefficients of gases. A.

534.23

2131. The attenuation of sound in small tubes. G. T. Kemp and A. W. Nolle. *J. Acoust. Soc. Amer.*, **25**, 1083–6 (*Nov.*, 1953).

An experimental investigation of the attenuation of sound in two air-filled tubes of 0·238 and 0·0292 cm inside radius in the frequency range from 3·8 to 20 kc/s was conducted, and the results compared with values of attenuation calculated from the Kirchhoff theory for rigid-walled tubes. Agreement of experimental with theoretical values was found within the accuracy of the experiment, provided that the comparison is made only with the portion of attenuation proportional to square root of frequency, as suggested by Fay. The attenuation was determined by a method which was different, in some respects, from those previously employed. The variable length closed tube was driven with a high-impedance source, and the input pressure sampled with a high-impedance microphone probe. The input pressure was recorded as a function of closed tube length. Since the input pressure can be assumed to be proportional to input impedance for these conditions, the attenuation can readily be determined from the ratio of the pressure maxima or minima. A.

534.23

2132. Apparatus and procedure for measuring the absorption of sound in gases by the tube method. F. A. Angona. *J. Acoust. Soc. Amer.*, **25**, 1111–15 (*Nov.*, 1953).

An apparatus for measuring the absorption of sound in gas mixtures has been developed and tested. The apparatus consists of a sound tube, a movable ribbon type speaker, and a fixed condenser microphone. The absorption is determined by recording

the sound pressure as the path length between the speaker and the microphone is increased. The measured attenuation coefficient is corrected for the effect of the tube and also for the attenuation due to the viscosity and heat conduction of the gas. Both frequency and pressure are variable and range from 2 to 10 kc/s and from 3 to 300 mm of Hg, respectively. A.

534.23

2133. The absorption of sound in gas mixtures. F. A. Angona. *J. Acoust. Soc. Amer.*, **25**, 1116–22 (*Nov.*, 1953).

The absorption of sound has been measured in CO_2, CS_2, C_2H_4O and in mixtures of the latter two gases with CO_2 over the frequency and pressure ranges, and by the method reported in the preceding abstract. The measured absorption coefficient was corrected for the effect of the tube and also for the absorption due to viscosity and heat conduction of the gas. The corrected absorption coefficient was then plotted as the attenuation coefficient per wavelength against the logarithm of the ratio of frequency over pressure. These curves were then compared to those determined from Bourgin's theory for mixtures of absorbing gases. The agreement between the observed attenuation and that predicted by the theory was within 5%. A.

534.23

2134. The absorption of sound in carbon dioxide contained in narrow tubes. L. E. Lawley. *Proc. Phys. Soc.* [*London*] *B*, **67**, 65–9 (*Jan.*, 1954).

Measurements were made with carbon dioxide contained in tubes ~1 mm diameter. Frequencies used were between 40 and 120 kc/s. Results showed that over a considerable range of frequency/pressure on either side of the relaxation peak of CO_2 the total absorption was given by the sum of the Helmholtz–Kirchhoff tube absorption and the thermal relaxation absorption of the gas. The tube absorption, however, was found to be a few per cent higher than that calculated theoretically. A.

534.23 : 532.7

2135. Variation of ultrasonic absorption with frequency in organic liquids. S. Parthasarathy, S. S. Chari and D. Srinivasan. *Acustica*, **3**, *No.* 5, 363–4 (1953).

The absorption (α) of ultrasonic waves has been measured by a radiation pressure method at 5, 10 and 15 Mc/s. The variation of α/f^2 with frequency (f) is discussed in relation to relaxation theory. In esters, generally, a pronounced decrease of α/f^2 with frequency occurs, thus justifying to some extent the relaxation theory. A.

534.23 : 621.389

2136. Electronic sound absorber. H. F. Olson and E. G. May. *J. Acoust. Soc. Amer.*, **25**, 1130–6 (*Nov.*, 1953).

Consists of a microphone, amplifier and loudspeaker connected so that for an incident sound wave the sound pressure at the microphone is reduced. The electronic sound absorber is thus a feedback system which operates to reduce the sound pressure in the vicinity of the microphone by 10 to 25 decibels over a frequency range of three octaves in the low-frequency portion of the audio range. The absorber may be used to reduce the noise over a small volume, that is, as a spot type noise reducer, or it may be used with an acoustical resistance to obtain a high order of sound absorption in the low-frequency range. A.

534.231

2137. The acoustic viscous boundary layer. E. Meyer and W. Güth. *Acustica*, **3**, *No.* 3, 185–7 (1953) *In German.*

This is investigated for sound waves in air in the neighbourhood of a rigid wall using illuminated floating particles seen under a microscope. A.

534.231.3

2138. The acoustic impedance of a porous layer at oblique incidence. J. S. Pyett. *Acustica*, **3**, *No.* 6, 375–82 (1953).

The specific normal impedance of a layer of anisotropic porous material for a plane wave incident in any direction is calculated in terms of the two propagation parameters of the material, the characteristic impedance and the propagation constant, assuming that one of the principal axes of the material is normal to the surface. Some impedance measurements at oblique incidence have been made on various thicknesses of rockwool, employing a transverse mode in a rectangular waveguide. Values of the propagation parameters for the refracted wave in the material are derived from these measurements and are in agreement with predicted values. The latter are based on normal incidence impedance measurements made on the same specimens, using the principal mode of the waveguide. A.

534.232

2139. The acoustic radiation of the rectangular piston membrane. H. Stenzel. *Acustica*, **2**, *No.* 6, 263–81 (1952) *In German.*

General formulae are obtained for calculating the sound field immediately in front of a vibrating membrane. The vicinal sound field is calculated by graphical integration and illustrated by many diagrams. Then general formulae for the radiation impedance are derived; and finally its two components are calculated and graphically constructed for different ratios of the sides of the rectangle ($a : b = 1 : 1$, $a : b = 2 : 1$, $a : b = 5 : 1$, $a : b = 10 : 1$). A.

534.232

2140. The sound radiation of plates excited in flexural vibration. K. Gösele. *Acustica*, **3**, *No.* 4, 243–8 (1953) *In German.*

The radiation of a plate excited in free flexural vibration is influenced by the ratio of the wavelength λ_B of these waves to the wavelength λ_L of the sound in air. The relation between the radiation of a plate in flexural vibration and its dimensions is calculated, and it is shown that small dimensions lead to a relatively strong radiation even for flexural waves whose wavelength is less than λ_L. A.

534.232

2141. Investigation of magnetostrictive vibrators at frequencies between 80 and 500 kc/s. G. Steinkamp. *Acustica*, **3**, *No.* 6, 399–404 (1953) *In German.*

Magnetostriction vibrators with resonance frequencies between 80 and 500 kc/s are investigated by

various methods. While the degree of efficiency is about 45% at 80 kc/s, it deteriorates to 8% at 500 kc/s. Different kinds of damping found in magnetostriction vibrators are discussed and measured. A.

534.232

2142. A tone burst generator. K. ONDER. *J. Acoust. Soc. Amer.*, **25**, 1154–6 (*Nov.*, 1953).

A tone burst generator is described for the production of electronically keyed oscillations free of transients. The unit consists of an oscillator, a keying circuit and a negative pulse generator with variable duration and repetition rate. The advantages of the tone burst method in testing the frequency and transient response of amplifiers and transducers are pointed out. Some applications including reverberation time measurements are also mentioned. The almost instant rise and decay of the tone bursts was achieved by providing practically zero impedance path to ground for the keying pulses. A.

534.232

2143. Remarks on measurements of liquid transducer efficiencies. H. THIEDE. *Acustica*, **3**, 449–51 (1953) [=*Akust. Beih.*, *No.* 3 (1953)] *In German.*

The measurement is described and a simple formula is developed which permits one to determine the efficiency from four measurements. A.

534.232

2144. On the directivity of spherical microphones. W. KUHL. *Acustica*, **2**, *No.* 5, 226–31 (1952).

The directivity patterns of microphones with circular plane diaphragms on the surface of a sphere have been measured for ten frequencies and are compared with the directivity patterns of point-like microphones on the surface of a sphere, as computed exactly by Schwarz. The directivity patterns for two frequencies have been calculated approximately for the microphone investigated. It is possible to get exactly the same response for all angles of incidence by adding the absolute values of the voltages of two point-like identical microphones situated on opposite points of a sphere. This does not hold for actual microphones with finite dimensions. Finally the frequency response curve of a microphone without any directivity is calculated, viz. a spherical microphone the diaphragm of which covers the whole surface. A.

534.232

2145. The directivity of spherical microphones. R. L. PRITCHARD. *Acustica*, **3**, *No.* 5, 359–62 (1953).

By employing the reciprocity principle, alternative solutions for the response of spherical microphones considered recently by W. Kuhl are given in terms of the response for sound emission. An existing solution for the sound field radiated from a vibrating spherical cap is used to calculate the directional response of a cylindrical microphone mounted in a sphere. Similarly, the frequency response of a completely spherical (non-directional) microphone is calculated with the help of the electroacoustic reciprocity theorem. Results of numerical computations for each type of calculation are given and are compared with Kuhl's results, which were obtained by direct integration of the sound pressure over the active surface of the sphere. A.

534.232

2146. A capacitative velocity receiver for structure-borne sound. K. TAMM AND E. AHA. *Acustica*, **3**, 270–3 (1953) [=*Akust. Beih.*, *No.* 2 (1953)] *In German.*

With this pick-up the displacement of the weakly braced membranes is made proportional to the velocity of the vibration of the housing by suitably adjusting the width of the air-gap between the membrane and the back plate, thus yielding a velocity-meter. Beside a short theoretical treatment the frequency-response characteristics (for different adjustments of the air-gap), the directional characteristic and the absolute sensitivity are given. A.

534.232

2147. The sensitivity limits of a condenser microphone in the low frequency range. H. GROSSKOPF. *Acustica*, **3**, 279–90 (1953) [=*Akust. Beih.*, *No.* 2 (1953)] *In German.*

The general relations determining the sensitivity of a condenser-microphone are derived. The parameters of the transmission coefficient of the microphone and of the noise component of the input circuit are treated separately. The most important parameter for the sensitivity is the amount of directivity which can be tolerated at the highest frequency. An attempt has been made, by definition of a "receiving quality," to determine an optimum of sensitivity. With uniform transmission of the audio-frequency range, i.e. sufficiently small size of the microphone, an equivalent noise level of about 10 phon can be obtained. A.

534.232

2148. Transient response of accelerometers. T. A. PERLS. Letter in *J. Acoust. Soc. Amer.*, **25**, 1199–200 (*Nov.*, 1953).

This letter criticizes some of the statements in a paper by Honnell [Abstr. 6566 (1953)]. Some common misconceptions about the response of accelerometers are briefly discussed and 11 references to recent papers on this subject are cited.

H. J. H. STARKS

534.232 : 534.015

2149. The coupling of mechanical and acoustic vibration systems. W. GÜTTNER. *Acustica*, **3**, *No* 4, 201–6 (1953) *In German.*

By coupling a Helmholtz resonator to a mechanical system in vibration it is possible under certain conditions of coupling, tuning and damping to attain a transduction coefficient relatively free from resonance, for application to telephones and microphones. Optimum conditions for bandwidth are attained when the radiation or pick-up takes place from the mechanical system itself without the Helmholtz resonator forming part of the sound path. A.

534.232 : 534.26

2150. On radiation and scattering from small cylinders. J. W. MILES. *J. Acoust. Soc. Amer.*, **25**, 1087–9 (*Nov.*, 1953).

The original work of Rayleigh on scattering and radiation of harmonic disturbances by small cylinders is extended to transient disturbances. The analysis is closely related to Ward's treatment of the aerodynamics of slender bodies in supersonic flow. A.

534.232 : 534.61

2151. A simple calibration technique for low-sensitivity transducers. W. J. GALLOWAY. *J. Acoust. Soc. Amer.*, **25**, 1127–9 (*Nov.*, 1953).

The cavitation threshold of water supersaturated with air at hydrostatic pressure is utilized as a pressure reference level against which the output of a transducer may be referred. The threshold may be determined within 0·2 decibel in a purely radial standing wave field. A simple system is described for performing the measurements. A.

534.232 : 621.395.616

2152. An electrostatic velocity microphone. A. D. FROST. Letter in *J. Acoust. Soc. Amer.*, **25**, 1198–9 (*Nov.*, 1953).

The construction and performance are described of a ribbon-type microphone suitable for transmission loss tests on test panels. The construction permits the ribbon element to be placed close to the surface of the test panel. G. F. HODSMAN

534.24

2153. Aspects of the concentration of ultrasonic energy. A. BARONE. *Acustica*, **2**, *No.* 5, 221–5 (1952).

The advantages offered by reflecting concentrators as compared with acoustic lenses in producing ultrasonics at high power are discussed and two types of concentrators capable of direct application to the usual quartz holders for vertical emission described. There follows a qualitative consideration of the structure of the ultrasonic field obtained by these systems. A.

534.24

2154. Reflection of acoustic waves from an inhomogeneous fluid medium. I. G. S. HELLER. *J. Acoust. Soc. Amer.*, **25**, 1104–6 (*Nov.*, 1953).

The reflection coefficient for plane waves incident obliquely on a medium in which the velocity decreases exponentially is computed approximately using the WKB method and compared with a computation from the rigorous solution. The approximate reflection coefficient $1/[16(\omega/g)^2\cos^6\theta + 1]$, where ω is the angular frequency, g is the velocity gradient at the start of the exponential decrease, and θ the angle of incidence, is within 0·05% of the rigorous value for $\omega/g \geqslant 5$ at normal incidence and within 5% of the rigorous value for $\omega/g \geqslant 20$ for angles of incidence up to about 45°. A.

534.242 : 534.23

2155. On the theory and design of acoustic resonators. U. INGARD. *J. Acoust. Soc. Amer.*, **25**, 1037–61 (*Nov.*, 1953).

Absorption and scattering from resonators in a free field as well as in walls are discussed. The effect of different aperture geometries on the resonance frequency of resonators is considered and illustrated by examples. Considering losses due to viscosity, heat conduction, and radiation, the optimum design for maximum resonance absorption is analysed, and the results are expressed in terms of design charts. Non-linear effects on the absorption and resonance frequency are also included, and a discussion of the onset of turbulence is presented. A.

534.242 : 534.23

2156. The near field of a Helmholtz resonator exposed to a plane wave. U. INGARD. *J. Acoust. Soc. Amer.*, **25**, 1062–7 (*Nov.*, 1953).

The near field of a spherical Helmholtz resonator exposed to a plane wave is computed and shown to be in good agreement with measurements. Comparison is made with the near field of a resonator terminating a cylindrical tube. A discussion of the calculation of the dissipation in the resonators is included. A.

534.242 : 534.37

2157. A study of the factors influencing the damping of an acoustical cavity resonator. R. F. LAMBERT. *J. Acoust. Soc. Amer.*, **25**, 1068–83 (*Nov.*, 1953).

Presents a systematic study of experimentally significant losses contributing to the damping of an acoustical cavity resonator. Absorption measurements in air on the (0, 1) wave of a round cavity were made by a resonance response method employing a transverse particle velocity pickup device. This study reveals that mechanical losses due to the vibrations of the walls are experimentally significant. Empirical relaxation time formulae are established for air at 24 and 27°C. The thermal and viscous boundary-layer loss formula is fitted to these data by choosing the thermodynamic ratio $\nu\rho_0/\mu$ equal to 1·31. A.

534.25 : 534.232

2158. An acoustic lens as a directional microphone. M. A. CLARK. *J. Acoust. Soc. Amer.*, **25**, 1152–3 (*Nov.*, 1953).

An acoustic lens combined with a conical horn can be used to obtain a highly directional microphone without some of the disadvantages of the parabolic microphone. The directional characteristics can be calculated satisfactorily if one assumes that the horn provides uniform flooding of the lens aperture. A.

534.26

2159. On acoustic diffraction through an aperture in a plane screen. J. W. MILES. *Acustica*, **2**, *No.* 6, 287–91 (1952).

The scattered wave consequent on the incidence of a monochromatic disturbance on a plane screen perforated by an aperture is constructed with the aid of generalized Fourier transforms. After formulating the integral equation defining this scattered wave, the total transmission cross-section is cast in variational form (of the Schwinger type) and the result compared with the Kirchhoff approximation. A similar result is given for scattering by a plane disk. Application is made to a circular aperture. A.

534.26

2160. The scattering of sound in a turbulent medium. R. H. KRAICHNAN. *J. Acoust. Soc. Amer.*, **25**, 1096–104 (*Nov.*, 1953).

The scattering of a sound wave in a medium undergoing shear flow confined to a finite region is investigated under the assumption that the total velocity field is everywhere small compared to the velocity of sound. Formulae are obtained for the angular distribution and frequency distribution of the scattered wave in terms of the four-dimensional Fourier transform of the shear velocity field. Under typical conditions, the cross-sections for the scattering of a

plane wave of frequency ω by a shear flow of given scale and spatial structure are approximately of the form $\omega^4 M^2$, where M is a characteristic Mach number of the flow. The coupling between the shear and longitudinal velocity fields has a tensor character such that the scattering vanishes at 180 degrees and at 90 degrees. The spectrum of the scattered sound wave is very sharp in the forward direction and becomes broader at larger scattering angles. Explicit expressions for the cross-sections are obtained for the case of scattering from a region of isotropic turbulence. When the frequencies of importance in the turbulence are small compared to the frequency of the incident sound wave, the average differential scattering cross-section can be expressed directly in terms of the energy spectrum of the turbulence. A.

534.3

2161. Comparative studies of organs. W. LOTTERMOSER. *Acustica*, **3**, 129–38 (1953) [=*Akust. Beih., No.* 1 (1953)] *In German.*

The quantitative acoustic judgment of organs becomes more and more important. In the present work octave-filter-analyses are given of the "plena" of organs of different sound quality, including high-quality baroque organs in southern Germany. Marked differences in the distribution of sound intensity are observed. Sound spectrogram and sound sensation can be associated unambiguously. The differences of the transient phenomena of organs with "Tonkanzelle" and with "Registerkanzelle" are particularly marked when striking plenum-sounds and can be made visible by octave-filter-oscillography. With "Tonkanzelle" the pipes influence each other, so that maximum amplitudes in the filter ranges are reached earlier than with "Registerkanzelle" where the coupling through the same "Kanzelle" is lacking. For best sound quality organs should be furnished with "Tonkanzelle," which by means of suitable disposition, "mensur" and intonation of single-registers, gives sounds with intensity distributions which are easy to describe. In this case, disagreeable sound effects, resulting from deviations, are easily avoided. A.

534.3

2162. The non-linear distortion of violin resonance boards. H. KURZ. *Acustica*, **3**, 148–51 (1953) [=*Akust. Beih., No.* 1 (1953)] *In German.*

Investigations have been carried out to establish a relation between the quality of a violin and the non-linear behaviour of its resonance body, a relation which was assumed by Skudrzyk. Measurements, using several methods, showed that there are only very small distortions; they occur with good as well as with cheap violins. A.

534.3 : 612.85

2163. The influence of non-linear distortions on the audibility of frequency vibrato. E. ZWICKER AND W. SPINDLER. *Acustica*, **3**, 100–4 (1953) [=*Akust. Beih., No.* 1 (1953)] *In German.*

The threshold of audibility of the frequency modulation of musical intervals is investigated. The investigations are carried out of very low modulation frequency as a function of the loudness level, with non-linear distortion of the second and third order on the transmission system. The more consonant the musical interval is, the earlier additional beats appear when the non-linear distortion increases. The non-linearity of the human ear takes part in this effect. From the measurements it can be concluded that the shares of the quadratic or cubic component of the non-linearity of the ear are individually markedly different. A.

534.32

2164. Acoustic spectrum terminology. T. E. HEINDSMANN. Letter in *J. Acoust. Soc. Amer.*, **25**, 1201 (*Nov.*, 1953).

It is proposed that "discrete component" be used to describe the individual elements comprising a line spectrum and that "tonal component" be used to describe its auditory equivalent. A.

534.321.3

2165. Measurement of the harmonic intervals of the scale based on the subjective perception of consonance. M. BARKECHLI. *Acustica*, **2**, *No.* 6, 242–50 (1952) *In French.*

Extends, to harmonic intervals, measurements which previous workers had confined to melodic intervals. Conclusions are: the ear has an actual sensitivity much greater than one would deduce a priori; the fourth sounds more "precise" than the fifth or octave; the assembly of harmonic intervals forms part of the natural scale; an interval chosen from among the lower tones (below 400 c/s) seems less "precise" than one taken from the fifth above. These experiments, in which the personal equation of the player has a certain part, confirm in general the results of earlier researches, viz. that there are really two scales; one the melodic scale of Pythagoras, the other the harmonic one of Aristoxenes. A.

534.321.3

2166. A new integral ratio chromatic scale. T. E. SIMONTON. *J. Acoust. Soc. Amer.*, **25**, 1167–75 (*Nov.*, 1953).

The IRC scale presented here in is neither a Pythagorean scale, nor a just scale, nor an equally tempered scale, as those terms are defined in *Acoustical Terminology*, but it is shown to possess the major advantages of all three. In a D–D octave, all of the notes are interconnected by a perfectly symmetrical arrangement of just fourths, and the note frequencies of the octave containing $C_4 = 256$ c/s are 144, 153, 162, 171, 180, 192, 204, 216, 228, 240, 256, 272, 288. A distinguishing characteristic of the IRC scale is that four ascending octaves commencing with a C embrace exactly four successive just fifths (C–G–D–A–E) immediately followed by four successive just fourths (E–A–D–G–C). The IRC scale, like the conventional just scale, is based on alternately conjunct and disjunct just tetrachords, but the IRC tetrachord intervals are the smoothly decreasing ones of 9 : 8, 10 : 9, 16 : 15, instead of the just scale irregularly arranged intervals of 16 : 15, 9 : 8, 10 : 9. The major and minor tones of the IRC scale are divided by the known superparticular proportion, giving, in addition to the just semitone 16 : 15, semitone ratios of 17 : 16, 18 : 17, 19 : 18 and 20 : 19. These five semitones are located in smoothly progressing order, forming three perfect harmonic series

embracing a just major third, fourth and minor third. The IRC scale is shown to be superior to the just and Pythagorean scales and to excel the equally tempered scale in modulation. If, as the author believes, Helmholtz was correct in his thesis that just intervals are musically better than equal tempered intervals, then the IRC scale is also superior to the equally tempered scale, possessing, among many other advantages, greater ease of tuning pianos and organs, and the ability to tune pianos, violins and cellos exactly alike and play them in the same temperament. A.

534.321.9

2167. Experiments in the demonstration of ultrasonic waves in liquids. F. HAUER AND G. KECK. *Acustica*, **3**, *No.* 6, 404–6 (1953) *In German.*

Methods suitable for a large audience are described. A.

534.321.9

2168. Problem of acoustic-optical image conversion. G. SPENGLER. *Nachrichtentechnik*, **3**, 399–402 (*Sept.*, 1953) *In German.*

A survey of known methods of visual display of ultrasonic waves, of importance in non-destructive material testing and general study of intensity distribution of ultrasonic fields. These methods make use: of scanning by piezoelectric generators in a way similar to iconoscopes, of changes in reflection properties of fine aluminium particles suspended in xylol, of deformation of liquids in ultrasonic fields, and of several ways of displaying visually a "contact image" by means of a convertor placed directly in the bombarded liquid (photographic, phosphorescent, fluorescent, thermocolour and phototropic methods). General characteristics of acoustic-optical convertors are considered in terms of ultrasonic optics; these convertors can be of reflective, transparent and absorbing type, and their performance, operation and application are described briefly. The bibliography contains 23 items, mostly German. A. LANDMAN

534.321.9 : 534.39

2169. The possibility of size reduction of substances in suspension, by means of ultrasound. W. GÄRTNER. *Acustica*, **3**, 124–8 (1953) [=*Akust. Beih.*, *No.* 1 (1953)] *In German.*

The destructive action of ultrasonic waves on aqueous suspensions of chemically inert, inorganic particles is investigated, especially with respect to its dependence on the properties of the sound field and of the suspensions. With the apparatus described best results are obtained with a frequency of 500 kc/s and concentrations of about $0{\cdot}002\ g\ cm^{-3}$. A.

534.323 : 612.85

2170. The loudness index. H. MOL. *PTT-Bedrijf*, **5**, 89–91 (*Aug.*, 1953).

The theme of the paper is that it is impossible to express sensations in numbers. The author regards the question "When do you judge the sound has become twice as loud?" as nonsensical. He considers that the simple, elementary sensation like "loudness" should be expressed by a "loudness index." Two sounds of different nature will sound equally loud if their loudness indices are equal. The index is a physical quantity for the sensation called loudness, but does not, as a number, represent loudness itself, the latter being a sensation which is beyond calculation. After discussing the Weber–Fechner and Fletcher–Munson work on loudness, with which he disagrees, the author goes into the physiological aspect. He considers which part of the aural system is responsible for the Weber–Fechner conclusions (the logarithmic law). A. B. WOOD

534.372

2171. The damping of bending vibrations of thin metal sheet by adhesive layers. H. OBERST AND K. FRANKENFELD. *Akust. Beihefte*, *No.* 4, AB 181–AB 194 (1952) *In German.*

The bending vibrations of thin sheet metal covered at one side by an adhesive layer of a damping material are treated theoretically. Measurements confirm the theoretical results. The investigation of a large number of damping materials results in a survey of their dynamical properties and of their damping efficiency on sheet metal. The results of practical importance are extensively discussed. A.

534.372

2172. Vibration of plates covered with a damping layer. A. VAN ITTERBEEK AND H. MYNCKE. *Acustica*, **3**, *No.* 4, 207–12 (1953).

A study is made of the damping of steel plates covered with a thin layer of bitumen emulsion containing schist powder or similar products. This damping is characterized by the constant τ which is the time corresponding to a decrease of the amplitude of the vibration to one-half. After the description of the experimental set-up, results obtained with plates of various thicknesses and covered with different materials are given. The damping as a function of temperature, between $-20°C$ and $+80°C$, is also determined. The check of the efficiency of the damping paint on a cement mill is also discussed. A.

534.372 : 532.623

2173. Experimental determination of the damping of pulsating air bubbles in water. M. L. EXNER AND W. HAMPE. *Acustica*, **3**, *No.* 2, 67–72 (1953).

The experiments showed that the damping of pulsating air bubbles in water for bubbles with resonant frequencies up to 100 kc/s can be explained theoretically by the energy losses due to sound radiation and heat conduction. From the result of the first part of the measurements, the validity of Minnaert's relation between radius and resonant frequency of the bubbles for frequencies higher than 50 kc/s became doubtful. Further investigations including direct measurements of the radii showed that the resonant frequencies of bubbles are considerably influenced by dust particles at higher frequencies. By association of dust particles at the surface of a bubble in the frequency range of 100 kc/s, the resonant frequency may rise up to $1{\cdot}5$ times the value given by Minnaert's formula. The damping of air bubbles is not influenced by association of dust particles. In liquids with small surface tension, where no dust particles remain at the surface, all bubbles showed normal properties. The damping due to viscosity seems to be considerably smaller than would be expected from Lamb's theory. A.

534.372 : 539.67

Experimental determination of the internal friction of wood. *See Abstr.* 2797

534.373

2174. Boundary layer absorption in a spherical resonator. I. D. CAMPBELL. *Acustica*, **3**, *No.* 6, 395–8 (1953).

Develops the theory of the decay of symmetrical modes of oscillation of a gas enclosed by a rigid spherical shell. The two damping agencies considered, the viscosity and thermal conductivity of the gas, lead to "effective" wall admittances which modify the loss-free modes. A numerical example is calculated in detail to illustrate the theory. A.

534.39 : 532.51

Acoustic streaming near a small obstacle. *See Abstr.* 2066

534.39 : 535.214 : 538.569

2175. Radiation pressure against perfect reflectors. J. E. RHODES, JR. *Amer. J. Phys.*, **21**, 683–7 (*Dec.* 1, 1953).

The concept of radiation pressure exerted against a reflecting surface by electromagnetic waves and by sound waves in gases is a familiar one. The absence of radiation pressure for sound waves in a "linear medium" is becoming well known. The equations are somewhat different for the radiation pressure for these two cases where the radiation pressure is not zero. The mechanisms usually called on to explain them (non-linearity of the equation of state of the gas, acceleration of charges in the reflector by the electromagnetic waves) are widely removed from each other. Consequently, it is not evident on the surface whether radiation pressure is a general property of waves or the capricious result of isolated physical phenomena associated with some waves. A generalized concept of radiation pressure is here developed and then applied to several kinds of waves: sound waves in various media, waves on strings and springs, electromagnetic waves. Also a simple demonstration of radiation pressure (for waves in a ripple tray) is described. A.

534.39 : 541.13

Effect of ultrasonics during anodic oxidation. *See Abstr.* 2813

534.39 : 771.5

2176. On the mechanism of the photographic effect of ultrasonic waves. G. S. BENNETT. *J. Acoust. Soc. Amer.*, **25**, 1149–51 (*Nov.*, 1953).

Experimental data are submitted indicating the existence of a direct action of ultrasonic waves on a photographic emulsion, contrary to the views of some other workers. All of the evidence obtained here indicates a closer correlation with the softness of the emulsion than with the known behaviour of ultrasonically produced luminescence. Information is presented as to temperature dependence of the image, effect of ambient pressure, light shielding and the behaviour of various types of commercial emulsions. A.

534.44

2177. The frequency analysis of some sound processes. R. BIERL. *Akust. Beihefte*, *No.* 4, AB 225–AB 235 (1952) *In German.*

Several examples of waveforms are analysed: (1) rectangular and exponential pulses, (2) rectangularly and exponentially bordered sine functions, and (3) the sum of two rectangular sine functions. By means of these examples it is demonstrated that often the frequency and duration of the individual frequency components can only be determined when the argument and the phase distribution of the spectral function is known. The width and the position of the maxima and the angular velocity of the vector are used. Moreover it is necessary to limit the number of components. The conditions for obtaining a practically steady complex spectral function are discussed. The labour of analysing is considerably larger for non-periodic than for periodic functions. A.

534.44

2178. Graphic representation of the resonance of an oscillator, applicable to the study of non-linear systems. P. LIÉNARD. *Acustica*, **3**, *No.* 4, 212–23 (1953) *In French.*

If acceleration and amplitude are taken as the parameters (in homogeneous co-ordinates) of a linear oscillator with only one degree of freedom, the resonance curve is an ellipse by means of which the fundamental properties of resonance can be derived. If the oscillator is not linear, the resonance ellipse is distorted and lobes appear. Thus, the influence of certain—even very small—parameters of non-linearity is pointed out; possible experimental applications are mentioned. A.

534.44

2179. Saw-toothed wave-forms in sound. G. J. BARBER AND T. F. W. EMBLETON. Letter in *Nature* [*London*] **172**, 1057–8 (*Dec.* 5, 1953).

Reference is made to the behaviour of sound pulses of finite amplitude in which the leading half-cycle of the wave is one of rarefaction. Such a pulse is formed (*a*) by direct generation at a loudspeaker placed at one end of the propagation tube, or (*b*) by the reflection of a leading compression pulse at the end of an "open" tube. The distortion of such a wave is discussed and the formation of discontinuities is illustrated in reproductions of records.

A. B. WOOD

534.522.1

2180. Ultrasonic grating remaining after the stopping of the ultrasonic waves. III. A. CARRELLI AND F. PORRECA. *Nuovo Cimento*, **10**, 883–92 (*July*, 1953).

For Pt II, see Abstr. 188 (1954). It is stated that other substances, besides the ones mentioned previously, namely HgCl and $BaSO_4$ in aqueous suspensions, show, at the stopping of the ultrasonic waves persistence of the diffracted lines of even order. Experiment shows further that the duration of persistence of the lines after the stopping of the ultrasonics, depends on the conditions of stationarity of the ultrasonic waves acting in the liquid and is maximal when the distance covered by the ultrasonics is an integral multiple of $\lambda/2$, λ being the ultrasonic wavelength in the liquid, and of the effect so observed a theoretic explanation is given. Measurements are given which for the various substances give the time of persistence of the lines t_p; as a function of the duration t_u; and the power of the ultrasonics with frequencies of 0·59, 1·77, 2·91, 4·13 Mc/s. A.

534.522.1

2181. Ultrasonic grating remaining after the stopping of the ultrasonic waves. IV. A. Carrelli and F. Porreca. *Nuovo Cimento*, **10**, 1406–14 (*Oct.*, 1953).

Besides the condition of standing waves, a necessary and sufficient condition for the persistence of the diffracted lines of even order is that at the stopping of the ultrasonic waves in the liquid should remain a phase grating formed by the periodic variation of the refraction index in correspondence with the solid particles which come to lie in the nodal planes. The theoretical order of magnitude of this Δn ($\simeq 10^{-6}$) is given with reference to the value of the refraction index of the pure liquid, and its value is measured experimentally. From the measurements of the duration t_p of the effect in time intervals following the instant of filling the vessel with the substance subjected to ultrasonics, the falling velocity of the suspended particles is determined. A new effect is described, related to the foregoing, namely that as, under suitable experimental conditions, the diffraction lines of even order remain visible after stopping the ultrasonic waves, so one observes during the action of the ultrasonic waves, for the diffracted lines of the lower orders an increased intensity of those of even order, and for the lines of higher order the presence of those of even order only. A.

534.6

2182. The suitability of dynamic earphones for the investigation of frequency-modulated tones. E. Zwicker and G. Gässler. *Akust. Beihefte, No.* 3, AB 134–AB 139 (1952) *In German.*

Ear canal resonances could prevent the use of dynamic earphones as calibrated headphones. However, a thorough investigation of these resonances shows that they are strongly damped and their intensity is less than $\pm$ 3 db. By using a set of two equalizer networks ahead of the earphones the frequency response of the transmission-factor of the earphones is made uniform within $\pm$ 3 db from 20 to 15 000 c/s. Since this frequency response is not only uniform but also very smooth and flat, it becomes possible to use these headphones for measurements of frequency-modulated tones too. The second and third harmonics due to non-linear distortion of the headphones are less than 0·1% of the fundamental at sound intensities of 90 db and for frequencies above 100 c/s. A.

534.614

2183. Sound velocity measurements in liquids with the Rayleigh disk. A. Kösters. *Akust. Beihefte, No.* 3, AB 171–AB 174 (1952); erratum, *No.* 4, AB 258 (1952) *In German.*

There are two ways of correcting König's formula for the density of the medium surrounding the Rayleigh disk, which were developed by A. B. Wood and L. V. King respectively. In order to determine which of these theories agrees best with experiments, two kinds of measurements have been made. The densities of disk material and surrounding liquid have been varied. Experiments confirm Wood's theory but do not agree with King's, this result being obtained already by Wood. Reliable measurements can only be made with rigid disks (not able to vibrate like free plates). Otherwise field distortion will occur which may result in changing the angular rotation of the disk. The rotation does not depend on the viscosity of the surrounding liquid. A.

534.614

2184. A method of measuring the velocity of sound in a few grams of a liquid. J. H. Janssen. *Acustica*, **3**, *No.* 6, 391–4 (1953).

A slight modification of the electrodynamical sound generator of St. Clair permits the determination of the resonance frequency of the free-free bar with and without a liquid column on top of it. The velocity of sound of the liquid follows from a very simple formula taking account of the small quantity of the liquid. The height of the column is about one quarter of a wavelength (2·5 cm for 10 kc/s). It is thought that the accuracy may be better than 0·1%. A.

534.614

2185. The measurement of the velocity of sound in liquids. G. M. Graham. *J. Acoust. Soc. Amer.*, **25**, 1124–7 (*Nov.*, 1953).

A new technique for the measurement of sound velocity in liquids has been developed, which is especially suited to frequencies in the range from 0·5 to 5 Mc/s. It employs an approximation to the boundary conditions in Guptill's closed form solution for the radiation field between two infinite walls with a piston source in one wall. Measurements have been made in distilled water at 0·6 and 7·6 Mc/s with an error of less than 0·2% in the low frequency measurements. No dispersion is indicated to the order of the experimental error, in the temperature range from 10 to 20°C. A description of the apparatus is given. A.

534.614 : 534.64

2186. The characteristics of water-filled tubes for impedance and sound velocity measurements. W. Kuhl. *Acustica*, **3**, 111–23 (1953) [=*Akust. Beih., No.* 1 (1953)] *In German.*

After a description of water-filled tubes for various acoustic measurements the lowering of sound velocity for low frequencies by the resilient tube wall and the dispersion at higher frequencies is dealt with. Disturbances of sound propagation in the water are caused only by free vibrations of the tube, the excitation of which is diminished by filters for structure-borne sound. The natural frequencies of various kinds and orders of free tube vibrations not yet described in the literature are given. As a significant number for the quality of the measuring tubes the ratio of maxima and minima in tubes terminated without absorption was measured in a large frequency range. It amounts to 58 db. In one case the sound insulation between the lower and the upper part of the tube, joined only by the tube wall, not by the water column, was examined. Various kinds of rigid terminations of specimens under test and the required quality of microphones for the exploring of the sound field in the tubes are described. The accuracy of the measurement of acoustic impedances is demonstrated by many examples (sound absorbers, microphones). The sound velocity was measured at various frequencies and air contents and an absolute accuracy of 0·7 to $1{\cdot}5 \times 10^{-3}$ was assured. A.

534.62

2187. Measurements in a measuring tank for water-borne sound with absorptive lining. W. Kuhl. *Akust. Beihefte, No.* 3, AB 140–AB 144 (1952) *In German.*

The sound field is investigated experimentally and is computed in the frequency range of 4 to 80 kc/s. A.

534.62

2188. The new acoustic chamber of the Technische Hochschule, Karlsruhe. H. Ebel and P. Maurer. *Akust. Beihefte, No.* 4, AB 253–AB 256 (1952) *In German.*

The design and construction of an anechoic chamber are described. By means of a combination of wedge-shaped absorbing material (glass wool) and damped Helmholtz resonators it is possible to keep the absorption factor above 99% for frequencies down to 160 c/s with a thickness of the absorbing layer of only 61 cm. Stationary wave tube measurements of the reflection factor of the absorbing layer are compared with measurements in the completed anechoic chamber. A.

534.62 : 538.566.2

2189. A new large anechoic room for sound waves and short electromagnetic waves. E. Meyer, G. Kurtze, H. Severin and K. Tamm. *Acustica*, **3**, 409–20 (1953) [=*Akust. Beih., No.* 3 (1953)] *In German.*

The construction of a large free-space room is described, the inner dimensions of which are $5{\cdot}5 \times 10 \times 14$ m^3, and which is anechoic for acoustic waves above 70 c/s and for electromagnetic waves above 1000 Mc/s (below 30 cm wavelength); here the reflection factor of the walls is below 10% referred to amplitudes. The walls are lined with wedges of 13×40 cm^2 in basic cross-section and 90 cm in length. They consist of several layers of glass-fibre boards of the density 150 kg/m^3. Three wedges form a unit (base 40×40 cm^2) which can easily be suspended on the wall. An air cushion (12 cm thick) behind the wedges together with slots between the wedges acts as an acoustic resonator, which shifts the low cut-off frequency of the absorption to 70 c/s. The glass-wool wedges are made electrically absorbent by sucking in graphite powder (6·7 weight per cent). Due to a careful preparation the fabrication of the wedges and the process to line the room with the wedges took only a few weeks. The reflection factor for perpendicular sound incidence was permanently controlled during the fabrication by means of a standing wave tube. Reflection measurements for oblique incidence were made with a model wall. A large net made from thin steel cables allows one to walk easily through the whole room. After the room was finished its acoustic quality was tested by means of reverberation time measurements (spark as a sound source, amplifier with a logarithmic characteristics, and cathode-ray oscillograph) and by measuring the deviations of the $1/r$-law of propagation (spherical sound source and unidirectional microphone). The latter procedure was also used for electromagnetic waves. The designed characteristics have been obtained. A.

534.62

2190. Resonance absorbers for water-borne sound. E. Meyer and H. Oberst. *Akust. Beihefte, No.* 3, AB 149–AB 170 (1952) *In German.*

The absorbers were smooth rubber sheets, 4 mm thick, pasted to steel plates of various thicknesses (ship walls). They contained cylindrical air cavities able to oscillate, the bigger ones being absorbing resonators. The number of cavities per unit area could be adapted to the thickness of the steel plate in order to attain the highest possible absorption in the desired frequency range. Reflection factors below 10%, i.e. absorption factors higher than 99%, have been obtained in the frequency range 9 to 18 kc/s. The design of the absorbers and the physical principles underlying the problem are described in detail. Some aspects of the measuring technique and the technology of rubber are mentioned. A.

534.62

2191. Pulse method for measuring reflection by water-borne sound absorbers in tubes. W. Kuhl, H. Oberst and E. Skudrzyk. *Acustica*, **3**, 421–33 (1953) [=*Akust. Beih., No.* 3 (1953)] *In German.*

The development of absorbers for water-borne sound covering the frequency range around 15 kc/s required special measuring methods. A pulse method is described which permitted the determination of the amounts and the phase angles of the reflection factors of absorber samples, having the shape of circular disks, in a tube. This method was in the first instance applied to the case of resonant absorbers. The influence of the narrow annular slot between the sample and the wall of the tube is especially treated, furthermore the necessary elimination of the systematic error which is caused by the slot. A.

534.64

2192. The practical representation of standing waves in an acoustic impedance tube. W. K. R. Lippert. *Acustica*, **3**, *No.* 3, 153–60 (1953).

It is shown that the envelope curves of the standing waves along the whole of an acoustic impedance tube with attenuation can be represented with the aid of diagrams. Suitable diagrams for easy application to impedance measurements are given and their usefulness is discussed in some specific cases. The position of the pressure minima are measured with different orifices of the probe tube and the resultant shifts of position are discussed. Special test measurements with a rigid terminal are proposed for specifying the tube performance. A.

534.64

2193. Acoustic impedance measurement by the transmission-characteristic method. A. F. B. Nickson and R. W. Muncey. *Acustica*, **3**, *No.* 3, 192–8 (1953).

The transmission-characteristic method has been developed to the stage where it is an accurate, simple and versatile method. The most suitable chamber dimensions are derived, construction of chambers is described and the impedance of a selected material at various angles of incidence is given for a wide range of frequencies. A.

534.64

2194. Measurement of acoustic resistances. A. Boleslav. *Slaboproudý Obzor*, **14**, *No.* 7–8, 332–4 (1953) *In Czech.*

Two methods of measurement are described. The

system for the measurement of large resistances comprises two pressure gauges and a standard acoustic resistance, the measured quantity being compared with the standard. The equipment for the measurement of small resistances consists of a differential pressure gauge, two vessels containing water, a smoothing tank and an oil pump. The unknown magnitude is determined by measuring the time taken for a known quantity of water to flow between the two vessels and noting the pressure. Some measured values are quoted. R. S. SIDOROWICZ

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 2982–91

534.75 : 591.485

The sense of hearing in mosquitoes. *See Abstr.* 2971

534.771

2195. The Békésy audiometer of the Technische Hochschule, Stuttgart. W. KAISER. *Akust. Beihefte*, *No.* 4, AB 235–AB 238 (1952) *In German.*

After several modifications the Békésy audiometer has been used to measure not only the threshold of hearing but also threshold curves within the whole auditory area, for instance the threshold of audibility of modulation. Such threshold curves may be measured with great accuracy and ease even by untrained observers and give information about the acuity of hearing. The most important parts of the audiometer are described and some examples of measurement given. A.

534.773.2 : 621.395.92

2196. Recent advances in hearing aids. L. G. HECTOR, H. A. PEARSON, N. J. DEAN AND R. W. CARLISLE. *J. Acoust. Soc. Amer.*, **25,** 1189–94 (*Nov.*, 1953).

The experience gained in fitting a large number of impaired persons with hearing aids is presented, showing illustrative ranges of impairment between 30 and 100 decibels fitted with three progressively-powered hearing aids. General features of such hearing aids are discussed, showing circuits and arrangements for peak clipping and automatic gain control. The microphone and air and bone receivers are described, considering features developed for providing optimum reliability in service such as moisture-proofing, and design arrangements providing miniaturization concomitant with robustness. A.

534.78

2197. Speech communication research. G. FANT. *I.V.A.* [*Stockholm*] **24,** *No.* 8, 331–7 (1953).

A progress report on research performed at the Speech Transmission Laboratory of the Royal Institute of Technology in Stockholm. Technical and linguistic aspects of speech analysis. Analysis and synthesis have been used for the study of information-bearing elements of speech. Some results from the synthesis of vowels and semivowels by means of a resonance analogue to the vocal tract are presented. This research is devoted to the general problems of speech communication. Possible applications are discussed. A.

534.78 : 612.85

2198. Observation of a further Tartini pitch resulting from a physical sinusoid added to a Tartini pitch. M. F. MEYER. *J. Acoust. Soc. Amer.*, **25,** 1195–7 (*Nov.*, 1953).

The sinusoidal air waves 9 + 6 + 2, shaking the skull, produce not only the commonly expected Tartini pitch 3 but also the rather surprising 1, but none other. However, these occur only within a total range that barely encompasses the human voice. For this restriction a plausible evolutionary hypothesis is suggested. The mathematical theory for the pitches 3 and 1 is furnished on the basis of a strictly hydraulic, i.e. non-vibratory, function of the cochlear phragma. A.

534.79

2199. The relation between the sone and phon scales of loudness. D. W. ROBINSON. *Acustica*, **3,** *No.* 5, 344–58 (1953).

Several previous investigators have studied the relation between loudness level and loudness sensation but have obtained discordant results. It is thought that a cause of these differences is that results are influenced by the test procedure. A new set of experiments is described in which a variety of sounds having known loudness level-intensity relations was used to make independent estimates of the phon-sone scale law over a wide intensity range. The uniqueness of this relation, which is prerequisite to its existence, is strongly demonstrated by the agreement of results for entirely different sounds and also by the consistency of the data for widely different test ratios. An unexplained difference remains between the scales for sounds ordered in ascending and descending loudness respectively, as has been found previously. The experiments were conducted in a manner directly related to the practical use of the sone scale, and were made with statistical control. The nature of the sone scale near the absolute threshold is discussed. A review of previous work leads to a single set of data representing tolerably well the results of various authors which may serve as a basis for future discussion of the standardization of the phon-sone relation. 17 refs. A.

534.83 : 534.374

2200. On numbering frequency bands. R. W. YOUNG. Letter in *J. Acoust. Soc. Amer.*, **25,** 1201–2 (*Nov.*, 1953).

Noise measurement filters found in many acoustical laboratories afford a number of contiguous pass-bands centred, respectively, on 100, 125, 160, 200, 250, 320, 400, 500, 640, 800 cycles per second or on frequencies related to these by factors of ten. It is now proposed that each band in this series be designated by ten times the common logarithm of its mid-band frequency. Thus the band centred on 1000 c/s would be No. 30, and the one next above would be No. 31, etc. (A good alternative would be simply the common logarithm: e.g. No. 3·0, No. 3·1, etc.)

A. B. WOOD

534.83 : 534.78

2201. Masking of speech by bands of noise. I. J. HIRSH AND W. D. BOWMAN. *J. Acoust. Soc. Amer.*, **25,** 1175–80 (*Nov.*, 1953).

The threshold of intelligibility for two-syllable

(spondee) words was measured in the presence of different levels of masking noise. Twelve different bands were used, one (20 to 6600 c/s) approximating a white noise and each of the other eleven containing a band of frequencies corresponding to a pitch interval of 250 mels. The absolute thresholds for these bands were also measured to permit transformation of the noise level from an absolute scale to a scale of sensation level. The results show linear relations between the masked threshold and noise level for white noise and for bands of noise between 394 and 1420 c/s. For noise bands above 1420 c/s this masking function is accelerated, while the two bands below 394 c/s yield sigmoid masking functions. Of the bands used, the most effective contained frequencies between 670 and 1000 c/s. The signal-to-noise ratio at threshold for this band was about −25 db while for bands above or below it became gradually smaller than −25db, reaching a minimum of −60 db for the highest and lowest bands. White noise was more effective than any band, giving a threshold S/N-ratio of −15 db. A.

534.833

2202. Sound insulation by rubber and steel springs. M. L. Exner. *Acustica*, **2**, *No.* 5, 213–21 (1952) *In German.*

In an investigation in the frequency range 20 to 2000 c/s good agreement between theory and practice was found. The larger internal damping of rubber springs—the loss factor being about ten times that of steel springs—produces good insulation over the whole frequency range. Besides simple mass + spring systems, mechanical filters were tried, i.e. systems of two or more springs separated by masses. Filters are better than simple systems above a critical frequency but have disadvantages at low frequencies. A.

534.833

2203. The sound absorption coefficient as a function of the angle of incidence of the sound. F.-K. Schröder. *Acustica*, **3**, *No.* 2, 54–66 (1953) *In German.*

An investigation of the sound absorption coefficient for a plane wave at oblique incidence has been carried out using a pulse method in a shallow space. The experiments are in good agreement with calculations in the case of porous absorbing materials and of foil facings in front of porous materials. Measurements with resonance absorbers agree only qualitatively with the theory. The absorption coefficient of resonance absorbers with partitioned air space between the facing and the back wall is found to be higher than expected in the frequency range above the resonance frequency. This can be explained by the existence of waves parallel to the surface in the air layer behind the facings causing parallel resonances, especially in the case of low damped resonators, and leading possibly to absorption coefficients increasing with increasing angle of incidence. The energy losses are primarily caused by frictional losses, which cannot be predicted quantitatively and which are much dependent in an uncalculable way on the method of mounting the facings and vibrating foils. Arrangements of wedges show an increase of the reflection coefficient towards large angles of incidence, which can be reduced by suitable orientation of the surface of the wedges with respect to the incident wave. A.

534.833.1

2204. The mechanism of sound transmission through single leaf partitions, investigated using small scale models. A. Schoch and K. Fehér. *Acustica*, **2**, *No.* 5, 189–204 (1952).

Presents: (1) a qualitative theoretical discussion of sound transmission with regard to the finite area of partitions, (2) a technique of measuring the transmission of sound through partitions by means of small scale models, on the basis of the similarity law relating linear dimensions and frequency, (3) measurements on homogeneous plates—representing single leaf partitions—with plane waves at varying angle of incidence as well as with diffuse (reverberant) sound. The results show the importance of the "coincidence effect" and the existence of additional "transmitted" waves caused by effects of the boundaries. A.

534.833.1

2205. Indirect sound transmission with joist and solid floors. H. J. Purkis and P. H. Parkin. *Acustica*, **2**, *No.* 6, 237–41 (1952).

Field values of airborne sound insulation of floating joist floors are considerably lower than laboratory values. To investigate this difference the indirect transmission past such a floor with an average airborne insulation of 43 db has been measured in the field by a method previously described [Abstr. 1598 (1952)]. The transmission past a similarly situated floating concrete floor, insulation 49 db, has also been measured for comparison. In both cases the value of airborne insulation was found to be determined mainly by flanking transmission, and it appears that the higher insulation of the concrete floor in the same structure is due to the junction of the floor with the walls attenuating the flanking energy. There is little indirect insulation with the joist floor since it connects with the walls at very few places. A.

534.833.1

2206. The measurement of the resistance of ceilings to impact sound, using sinusoidal excitation. T. Lange. *Acustica*, **3**, *No.* 3, 161–8 (1953) *In German.*

Describes investigations of the sound pressure level of impact sound. The vibrations of the ceiling are produced both by the usual hammer machine and by an electromagnetic system for sinusoidal excitation. The difference of both sound pressure levels is in agreement with the spectrum of the impacts with the hammer. Measurements in buildings demonstrate the adequacy of the method of sinusoidal excitation. This method has several advantages. In the case of excitation at one point the amplitudes of flexural waves on a floor decrease with the square root of the distance. A.

534.833.4

2207. Measurement of structure-borne sound insulation, using flexural waves. M. L. Exner and W. Böhme. *Acustica*, **3**, 105–10 (1953) [=*Akust. Beih., No.* 1 (1953)] *In German.*

The first part of this work describes an apparatus for determining the sound insulation factor of flexural waves by measuring the reflected and the transmitted part of the wave. In the second part results of these measurements are stated. The frequency dependence of sound insulation of thin

elastic layers is discussed by means of a formula given by Cremer. With thicker layers resonance phenomena occur which, as in the case of longitudinal waves, reduce the insulation the more the smaller the internal damping of the material is. The phase velocity of the insulation material is computed from the resonance frequencies and its dependence on frequency is compared with Firestone's curve. A.

534.834

2208. Calculation of sound propagation in structures. L. Cremer. *Acustica*, **3**, *No.* 5, 317–35 (1953).

The different types of structure-borne sound waves are described and the wavelengths deduced. Especially the radiation into the air and the reciprocal transition are discussed. The impedances of simple types of structure are calculated and also the spectrum of impact sounds. Finally the paper deals with the reduction of longitudinal and flexural wave amplitudes afforded by change of section, transition from rod to plate, corners, elastic layers and impeding masses. A.

534.837

2209. A practical noise reduction treatment for Diesel engines. J. E. Ancell. *J. Acoust. Soc. Amer.*, **25**, 1163–6 (*Nov.*, 1953).

A noise reduction treatment for Diesel engines is described, which, though not the ideal approach to the problem, is practical, economical and applicable to both new engines and those already in service in the field. This treatment was designed making use of the results of a survey of the relative importance of the various noise sources on the Diesel engine. The treatment consisted of a set of sheet metal covers, lined internally with acoustical absorbing material, which were mounted directly over the noisy areas of the engine by means of built-in vibration isolation. Noise reductions for the direct sound were at least 8 to 12 db, which were observed at a distance of one foot from the engine. The total loudness of the engine noise at 6 ft was reduced from 320 to 220 sones. This is a substantial improvement with regard to voice communication in the immediate vicinity of the engine. The Speech Interference Level of the engine noise at 6 ft was reduced from 87 to 82 db. A.

534.839

2210. The measurement of noise with the sound spectrograph. G. E. Peterson and G. Raisbeck. *J. Acoust. Soc. Amer.*, **25**, 1157–62 (*Nov.*, 1953).

The sound spectrograph principle may be employed in the quantitative measurement of noise. Measurements may be made with the conventional amplitude section circuit in which, in the customary use of the sound spectrograph, each section provides observation during a few milliseconds of the signal time. A long integrating time circuit for the amplitude sectioner has been developed which provides integration over a period of as much as one or two seconds of signal time. The amplitude sectioning circuit of the sound spectrograph may be employed to determine the relationship between the level of a pure tone and the power-per-cycle of noise. Measurements were made for various types of amplitude analysis with the sound spectrograph. A study was made of the degree to which the section displays conform to the computed values of noise level. A.

534.84

2211. An empirical acoustic criterion. T. Somerville. *Acustica*, **3**, *No.* 6, 365–9 (1953).

Describes the derivation of a tentative empirical acoustic criterion related only to the acoustic characteristics which are directly audible. It makes use of data derived from the analysis of reverberation time/frequency characteristics, combined with an analysis of the irregularity of the decays in pulsed glide displays. It is realized that modifications to the criterion may be necessary after more extensive use, but in its present form the agreement with the subjective assessments of B.B.C. studios is good. A.

534.843

2212. Diffusion in room acoustics. W. Furrer and A. Lauber. *Acustica*, **2**, *No.* 6, 251–6 (1952) *In German.*

It has become more and more evident in the last few years that the classical quantities are not sufficient to describe adequately the acoustic behaviour of a room. In addition to the volume, the reverberation time, and the shape of the room determined by geometrical considerations, the homogeneity of the sound field, which may also be called "diffusion," plays a very important part. It is shown that the frequency irregularities existing in the stationary state, which have been known for a long time, are not a direct measure for this diffusion. It is possible, however, to prove empirically that the "mean height of a peak" of these irregularities is an important parameter directly related to the homogeneity of the sound field. It is determined—for the frequency regions around 375 c/s and 1650 c/s—for 11 rooms, whose volumes range from 37 m^3 to 20 000 m^3. A.

534.843 : 534.231.3

2213. The boundary conditions of the equation of sound. T. Vogel. *Acustica*, **2**, *No.* 6, 281–6 (1952) *In French.*

A wave theory of room acoustics should account for those of Sabine's results which are substantiated by facts. These are discussed, and it is shown how the boundary condition conducive to the notion of specific normal impedance is most naturally introduced. However, the consequences of that hypothesis do not seem in good accord with experiments, in one simple case at least; caution should therefore be used when applying this boundary condition. A more involved condition is tentatively suggested, taking into account two specific impedances: one normal and one tangential. A.

534.843.3

2214. The effect of wall shape on the decay of sound in an enclosure. J. W. Head. *Acustica*, **3**, *No.* 3, 174–80 (1953).

A two-dimensional room is considered in which three of the "walls" are straight and the fourth has small, regularly spaced symmetrical projections. The method of Feshbach (1944) is applied to determine the effect of the projections on the natural frequencies and normal modes of the room; explicit formulae are obtained for rectangular, circular and triangular projections. Recent experimental results [Abstr. 1602

(1952)] suggest that studios or halls with rectangular coffering may have superior subjective properties to those having other types of projection with comparable dimensions. The results here given appear to provide a theoretical reason for this superiority of rectangular coffering. A.

534.844

2215. Direction and time dependence of echoes in rooms. R. THIELE. *Acustica*, **3**, 291–302 (1953) [=*Akust. Beih.*, *No.* 2 (1953)] *In German.*

An equipment is described which allows one to measure the sound intensity coming from different directions to a given point in a room by means of a directional microphone (parabolic reflector with a microphone in focus) if a sound source is stationarily emitting a broad frequency band. From the measured intensity with respect to direction a measure for the "directional diffusion" of a point in the room can be derived. At a "directional diffusion" of 100% the directional microphone would indicate a constant value for all room directions (ideal reverberation room). Due to the sound coming directly from the source and to the first reflections at the walls lower values are obtained. For different rooms "directional diffusions" between 13 . . . 66% have been measured. In the second part the variation of sound pressure with time at a given point has been registered by means of an oscilloscope when a sound source is emitting a short pulse. At the same time the ratio of sound energy arriving during the first 50 msec to the whole energy arriving at the observation point has been measured. For this ratio, characterizing the "definition" of a place in a room, values from 10 . . . 90% have been measured in different rooms. A.

534.846

2216. The acoustics of the Royal Festival Hall, London. P. H. PARKIN, W. A. ALLEN, H. J. PURKIS AND W. E. SCHOLES. *Acustica*, **3**, *No.* 1, 1–21 (1953).

Describes in some detail the acoustical design, the test concerts held in it before the opening, the objective measurements made in it and the comments about its acoustics that have been made during the first eighteen months since its opening. These comments show that the "definition" is excellent, but that for some types of music more "fullness of tone" would be desirable. It is concluded that the reverberation time is the only objective measurement which, at the present stage of development, is of practical use. Its value in the Royal Festival Hall when full is 1·5 sec (at 500 c/s), which is 0·2 sec shorter than the optimum value given by Knudsen and Harris for a hall of this size. It seems probable that the "fullness" would be adequate if the reverberation time could be lengthened to 1·7 sec or somewhat longer. A.

534.846.6

2217. Sound reflection at surfaces with periodic structure. Model investigations with ultrasound in the region of 15 to 60 kc/s. E. MEYER AND L. BOHN. *Akust. Beihefte*, *No.* 4, AB 195–AB 207 (1952) *In German.*

The efficacy in sound diffusion of plane walls having diffusing elements equidistantly fixed to their surfaces has been investigated by measuring the geometrical reflections in the frequency range 15 to 60 kc/s. A narrow beam of sound (angular width about 20°) is reflected at the surface of a test-wall and the angular distribution of the reflected sound is recorded over a range of nearly 180°. From these measurements a "diffusion-index" is obtained (ratio of reflected sound energy outside the "20°-region" of the geometrical reflection to the total of the reflected energy). For three different kinds of diffusing elements (with hemi-cylindrical, triangular and rectangular cross-section) the dependence on the following parameters has been considered: (1) ratio of the grating constant to the wavelength of sound ("frequency response"); (2) ratio of the width of the individual elements to the grating constant; (3) ratio of the depth of the diffusing arrangement to the wavelength of sound; (4) angle of incidence. All parameters have been investigated with the grating in front of a perfectly absorbing backing as well as in front of a perfectly reflecting backing. A.

534.862.4 : 534.843.3

2218. The acceptability of speech and music with a single artificial echo. R. W. MUNCEY, A. F. B. NICKSON AND P. DUBOUT. *Acustica*, **3**, *No.* 3, 168–73 (1953).

Groups of subjects seated in a room of 0·15 sec reverberation time assessed whether or not a single artificial echo, added to speech or music previously heard with little or no echo, was disturbing. The artificial echo varied in intensity level from equal to the direct sound to −40 db and in delay from 30 to 1000 msec. The results obtained for speech differ from those of Haas owing to the different reverberation time. An acceptable-echo-level/delay criterion deduced from the results is shown to be in agreement with pulse work in motion picture theatres. A.

534.862.4 : 537.228.4 : 621.395.62

2219. Electro-optic sound-on-film modulator. R. O'B. CARPENTER. *J. Acoust. Soc. Amer.*, **25**, 1145–8 (*Nov.*, 1953).

The electro-optic effect in the crystal ammonium dihydrogen phosphate provides a high-speed light valve with robustness, long life and ease of handling not possessed by the similar Kerr effect in liquids. A practical sound reproduction unit for making variable density 35 mm tracks is described. Frequency response of the light valve is flat to over 20 000 c/s, the overall system being limited to about 10 000 by the slit width film speed effect. Tests of distortion and sound quality in the sound tracks obtained are described. A.

534.862.6 : 534.44 : 621.395.62

2220. Distortion in phonograph reproduction. H. E. ROYS. *J. Acoust. Soc. Amer.*, **25**, 1140–4 (*Nov.*, 1953).

Three distortion methods, the harmonic, the SMPE intermodulation and the CCIF, a difference frequency, have been studied, mainly on a theoretical basis, as a means of analysing distortion encountered in gramophone reproduction. The harmonic method is somewhat difficult to apply and some of the harmonics may be beyond the range of the system. The IM has been used in the past with considerable success, and appears to be a good method of analysing tracing distortion. The difference frequency method

appears to be somewhat insensitive to tracing distortion but offers theoretical advantages in that the analysis may be made right up to the cut-off frequency of the system, practically it is somewhat difficult to apply. A.

534.862.6 : 612.85

2221. The perceptibility of non-linear distortion in the transmission of two-note chords. R. FELDTKELLER. *Akust. Beihefte, No.* 3, AB 117–AB 124 (1952) *In German.*

Comparing the timbre of a prolonged fifth before and after transmission by a non-linear system, changes of tone quality as small as a fraction of 1% are perceptible with cubic distortion, changes of a few per cent when quadratic distortion occurs. Loud and high intervals are affected most by distortion. Harmonics produced by the transmission system not only falsify the timbre but make small mistakes of intonation more conspicuous. A.

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535.1

2222. Deductions concerning the constitution of light-energy. J. STARK. *Z. Phys.*, **136,** *No.* 2, 221–3 (1953) *In German.*

To explain the author's experimental results [Abstr. 4676 (1953)] which indicated a deflection of light by an inhomogeneous electric field, it is suggested that the electric field of light is not oscillatory, and that the frequency of light is a frequency of rotation of the electromagnetic energy in the light particle.

P. M. DAVIDSON

535.1 : 538.566

2223. Series expansions of rays in isotropic non-homogeneous media. S. GORN. *Quart. appl. Math.*, **11,** 355–60 (*Oct.*, 1953).

Recurrence formulae are derived for the coefficients occurring in series expansion solutions of the differential ray equation. The method consists in expressing the path in terms of the conventional parameters of differential geometry and obtaining derivatives by means of the Frenet–Serret formulae. G. D. SIMS

535.214 : 538.569 : 534.39

Radiation pressure against perfect reflectors. *See Abstr.* 2175

535.214.4

2224. Detectors of radiation. W. L. HYDE. *Trans Instrum. Meas. Conf.*, **1952,** 120–5.

A general review of detectors and the quantum basis of their limiting sensitivity. Comparisons between the eye, photographic film and television cameras are made. Factors determining the signal-to-noise ratio of infrared detectors are discussed in detail. R. W. FISH

535.22 : 538.566

The measurement of the velocity of electromagnetic waves and the refractive index of air at microwave frequencies. *See Abstr.* 2601

535.241

2225. Measurement of luminous flux from projectors. R. G. WEIGEL. *Lichttechnik*, **5,** 296–8 (*Sept.*, 1953) *In German.*

Although the distribution curve of luminous intensity in a headlight beam cannot be determined by making measurements at short distances, the luminous flux can be found by making a number of measurements of illumination at any convenient fixed distance r from the projector. The total flux is equal to $2\pi \int E_\alpha r^2 d(1 - \cos\alpha)$ where E_α is the illumination at an angle α from the axis of the beam. The integration is performed graphically on a network in which the scale of abscissae is proportional to $(1 - \cos\alpha)$. J. W. T. WALSH

535.242.43

2226. Light modulation by openings in rotating shutters. G. C. MÖNCH. *Optik*, **10,** *No.* 8, 365–74 (1953) *In German.*

A rotating shutter interrupts a beam of parallel light passing through an aperture. The amplitude modulation of the emergent beam is determined as a function of the aperture and shutter geometry. Possible configurations yielding pure sine wave modulation are discussed. R. W. FISH

535.247 : 771.534.5

2227. An automatic recording photographic densitometer. G. BARNES. *J. Opt. Soc. Amer.*, **43,** 1176–80 (*Dec.*, 1953).

For certain applications such as the detailed analysis of field emission patterns, to obtain the current density distribution at the field cathode, complete photographic density scanning of a negative is required. This paper describes a projection densitometer which automatically plots a function of photographic density *v.* position by a polar scanning of the negative in steps of two degrees or more. The resulting graphs, as well as a calibration trace obtained by a single scanning of a photographic step wedge, are recorded photographically. The instrument, which may also be operated manually, has the advantage of high resolution and can be used for the investigation of fine detail on the negative. A.

535.247.4

2228. New photoelectric brightness spot meter. F. F. CRANDELL AND K. FREUND. *J. Soc. Motion Picture Televis. Engrs*, **61,** 215–222 (*Aug. II*, 1953).

A new photoelectric brightness meter covering an angle of only $1\frac{1}{2}°$ and measuring brightness from 0·1 ft-L to 1 000 000 ft-L is described. Applications such as its use in measuring screen brightness for standard and 3-D projection screens are discussed. A.

535.247.4

2229. Design characteristics of a photo-electric brightness meter. K. FREUND. *Illum. Engng*, **48,** 524–6 (*Oct.*, 1953).

Describes a photoelectric instrument for measuring the luminance of a small area (1·5°) over the range 0·1 to 10^6 footlamberts. The lens used is a four-element $f1·9$ focusing on to a photoemissive cell colour corrected to the C.I.E. standard observer. The photocurrent is amplified by a factor up to 10^6,

all batteries required being housed in the instrument which weighs altogether about 5 lb. There are filters for measuring in the red and the blue and for giving the instrument an approximation to the spectral sensitivity of the image orthocon. J. W. T. WALSH

535.3

2230. A question of geometric optics. G. COLOMBO. *R.C. Accad. Naz. Lincei*, **14**, 627–31 (*May*, 1953) *In Italian.*

The author discusses the propagation of plane waves through media whose surfaces of constant refractive index are planes or concentric spheres. Some fundamental theorems governing the ray path are derived. R. W. FISH

535.3 : 518.3

Nomograms for optical calculation and manufacture. *See Abstr.* 1943

535.31

2231. Theoretical study of optical systems with quadrics of central revolution. A. DURÁN AND J. CASAS. *An. Real Soc. Españ. Fis. Quim.*, **48**(A) 293–304 (*Sept.–Oct.*, 1952) *In Spanish.*

After a brief historical introduction the path of meridian and skew rays is studied. Formulae for third-order aberrations are also given. A.

535.31

2232. Design of machines for cutting quadrics of revolution by means of flat tools. A. DURÁN AND J. CASAS. *An. Real Soc. Españ. Fis. Quim.*, **48**(A) 305–22 (*Sept.–Oct.*, 1952) *In Spanish.*

The design of four machines for manufacturing second-order surfaces is given. With fixed machine parameters, the curves can be obtained without modification of the tool, and can be tested in the course of work. Errors and tolerances are studied. A.

535.317

2233. Considerations on the choice of glasses in apochromatic objectives. J. BARCALA HERREROS. *An. Real Soc. Españ. Fis. Quim.*, **48**(A) 289–92 (*Sept.–Oct.*, 1952) *In Spanish.*

Once the powers of the first and second lenses, and consequently that of the third, are fixed, the third glass is chosen from among those of low dispersion. Two functions relating the dispersions of the first and second glasses are obtained. From the curves of these functions the three glasses concerned are determined. A.

535.317

2234. A system of simple equations for the paraxial determination of a triplet. F. WEIDERT. *An. Real Soc. Españ. Fis. Quim.*, **48**(A) 339–48 (*Nov.–Dec.*, 1952) *In Spanish.*

Three equations, by means of which the three focal distances of a triplet for an arbitrary object distance can be determined, are first developed, the data being the distances between the lenses e_1 and e_2 as well as the heights ratios $\mu_2 = h_2/h_1$ and $\mu_3 = h_3/h_1$. μ_2 and μ_3 are got from an approximate paraxial condition for elimination of the distortion and from the Petzvala condition; this may be done for given indexes of refraction by solving of two equations, or otherwise by calculating μ_3 for several values of μ_2 and choosing the most convenient values. Finally, equations are given for two pairs of ν values of the triplet for given residual errors by means of which equations, the necessary values of ν are deduced. These equations result from the general formulae for chromatic errors of the frontal distance and magnification. A.

535.317

2235. Determination of the powers of doublet and triplet lenses. C. MORAIS. *An. Real. Soc. Españ. Fis. Quim.*, **49**(A) 217–28 (*July–Aug.*, 1953) *In Spanish.*

The problem of determining the power of the three lens objective has been resolved by various methods. This work, following the method of Berek, tries to give a more general formula, from which the designer may obtain advantage in calculation. It is preceded by a simple study of the doublet. A.

535.317

2236. Method for maintaining the focal distance or the lateral increase for correcting an optical system for variation of any radius. I. F. WEIDERT. *An. Real. Soc. Españ. Fis. Quim.*, **49**(A) 229–34 (*July–Aug.*, 1953) *In Spanish.*

Besides the method of Roll (1935) a more general formula is given in which the space of object and image need not be filled with air. The derivation is made with the old determinants of Seidel h and σ respectively σ'. For the constancy of the lateral magnification at which the distance a of the object from the principal plane of the object-space of the system is given, then there must also be constancy of the focal distance and, for the trigonometric computation, each time the object-distance s_1 from the first crest must be calculated. A.

535.317

2237. Method for maintaining the focal distance or the lateral increase for correcting a symmetrical system. II. F. WEIDERT. *An. Real. Soc. Españ. Fis. Quim.*, **49**(A) 235–8 (*July–Aug.*, 1953) *In Spanish.*

A formula is developed for the computation of the two innermost radii of a symmetrical system if a certain focal distance must be maintained during its correction. With this the distance between the two innermost surfaces must be kept constant; and the object- and image-space as well as the space between the two innermost surfaces may be filled with substances of any refractive index. Therefore the formula can also be used when the symmetrical system has an equilateral lens in its centre. A.

535.317.25

2238. A contribution to the improvement of resolving power. M. FRANÇON. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 283–7 (1953) *In French.*

If light from a single pinhole source or its image is split with a Savart polariscope two diffraction patterns with relative polarizations differing by 90° are formed with relative displacement of the central position. If the system is placed between crossed nicols the centre of the image system appears black. If the source is two close pinholes, the blackness is incomplete and the existence of the two objects may be recognized. A lowering of contrast of 10% appears when the

objects are $0{\cdot}3\lambda/D$ apart, where D is the diameter of the objective. D. H. WHIFFEN

535.317.25

2239. A method for improving the resolving power of optical instruments based on phase amplification. A. Maréchal and P. Lacomme. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 354–7 (1952) *In French.*

If a point source is brought to an intermediate focus in a telescope and its central fringes partly obscured by an obstruction, a small angular displacement of the source moves its diffraction pattern across the obstruction and gives rise to a magnified displacement of the final image. In this fashion the resolution of two point sources may be increased at the expense of brightness by the use of such an obstructor and this is shown to be so by experiment. D. H. WHIFFEN

535.317.6

2240. An arrangement of optical calculations for use with a calculating machine. J. Casas and J. Barcala. Note in *An. Real. Soc. Españ. Fis. Quim.*, **49(A)** 191–6 (*May–June*, 1953) *In Spanish.*

Arrangements of standard formulae for paraxial rays, for extra-axial rays lying in a meridian plane and for the astigmatism (Abbe formula) are given. R. F. BARROW

535.317.9

2241. Procedure for calculating an aspherical surface that corrects the spherical aberration of an optical system. F. Villar. *An. Real. Soc. Españ. Fis. Quim.*, **48(A)** 283–8 (*Sept.–Oct.*, 1952) *In Spanish.*

A graphical procedure is given for rapidly obtaining the meridian of an aspherical surface, which is a corrector of a spherical aberration. This meridian is obtained by means of points from polar co-ordinates. These data can be introduced into the machining apparatus. It is thought in this method that the aspherical surface is obtained from the spherical one, by superimposition of a thin covering of the same index and variable thickness. If ρ_0 is the vector radius in the vertex, this new procedure gives immediately the thickness of the covering by $\rho - \rho_0$, in a sufficient number of points. A.

535.317.9 : 522.2

2242. Aspheric field correctors for large telescopes. A. B. Meinel. *Astrophys. J.*, **118**, 335–44 (*Sept.*, 1953).

The application of generalized aspheric aberration equations to the problem of providing aberration-free fields for large parabolic telescopes yields families of solutions that can substantially correct for third- and fifth-order coma and astigmatism. A.

535.322.4

2243. Principle and applications of a phase contrast refractometer with high accuracy for gases and liquids. E. Ingelstam. *Trans Instrum. Meas. Conf.*, **1952**, 35–9.

The phase-contrast refractometer is about 100 times as sensitive as previous refractometers, accuracies of the order of $\lambda/1500$ being achieved with photo-electric photometry. A description is given of the instrument and its accessories, and some applications are discussed. R. W. FISH

535.322.4

2244. Ophthalmic refractometers. H. Hartinger. *Optik*, **10**, *No.* 10, 503–5 (1953) *In German.*

After a brief review of existing instruments, the author describes a new refractometer which is said to be simple in construction and easy in use. R. W. FISH

535.322.4 : 535.417

2245. Some new interferometric techniques and their application to physico-chemical problems. H. Svensson. *Trans Instrum. Meas. Conf.*, **1952**, 58–63.

A description is given of an astigmatic modification of the Rayleigh interference refractometer suitable for physico-chemical measurements. A recording system is described for obtaining the refractive index derivative. A system is described for securing simultaneously a recording of the refractive index and its derivative. The procedure described is adapted for use with a Kösters interferometer. S. TOLANSKY

535.323 : 535.345

2246. Further measurements on the optical properties of lead sulphide, selenide and telluride. D. G. Avery. *Proc. Phys. Soc.* [*London*] *B*, **67**, 2–8 (*Jan.*, 1954).

Earlier work is briefly reviewed. Measurements, using reflection techniques, of the optical constants of all three compounds are reported for wavelengths up to 6 μ. The variation of the optical constants with temperature for some specimens of PbS is described and discussed, and the effect on the constants of baking the specimens in O_2 at a few millimetres pressure is described. A.

535.323 : 535.345 : 539.234

Evaporated magnesium fluoride films. *See Abstr.* 2776

535.326 : 535.417

2247. An interferometric method for recording the refractive index derivative in concentration gradients. III. The construction of the optical differentiators and an experimental test of the method. H. Svensson, R. Forsberg and L.-A. Lindström. *Acta chem. Scand.*, **7**, *No.* 1, 159–66 (1953).

For Pt II, see Abstr. 6833 (1951). Practical details of optical differentiators are given. Simultaneous exposures of derivative, integral and reference fringes can be taken if a diffusion cell with at least 5 mm internal lateral dimension is available. The optical differentiation has been compared with numerical differentiation in a quantitative test experiment. Both methods were found to give the same result within the experimental errors, which were smaller for the optical differentiation. The optical method is also much more convenient and rapid. R. W. FISH

535.33.07

2248. Echelle spectrographs. D. Richardson. *Trans Instrum. Meas. Conf.*, **1952**, 52–7.

Outlines the properties of echelles and methods of producing them by lapping on glass or by ruling on 10 μ thick aluminium coatings on glass. Different methods of mounting them crossed with a prism or grating are (1) with a pair of concave mirrors before the slit of a stigmatic spectrograph; (2) in place of the mirror of a Littrow spectrograph; (3) as part of a Wadsworth grating spectrograph. G. F. LOTHIAN

535.33.07

2249. Multiple monochromators. IV. A triple monochromator and its application to near infrared, visible, and ultraviolet spectroscopy. A. WALSH AND J. B. WILLIS. *J. Opt. Soc. Amer.*, **43**, 989–92 (*Nov.*, 1953).

For Pt III, see Abstr. 7147 (1952). The method described previously was used to convert a conventional monochromator to a triple monochromator, and spectra in the near infrared, visible and ultraviolet have been recorded to illustrate the performance of the instrument in these regions. A limitation to the use of this method for measuring visible and ultraviolet absorption spectra is the noise caused by the relatively large intensity of unmodulated light of unwanted orders falling on the photomultiplier at the same time as the third-order modulated radiation which it is desired to record. Various ways are suggested for overcoming this difficulty. A.

535.33.07

2250. Experimental performance of curved slits. W. G. FASTIE. *J. Opt. Soc. Amer.*, **43**, 1174–5 (*Dec.*, 1953).

Experimental data is presented that demonstrates very high resolving power in an Ebert-type spectrometer when the jaws of the entrance and exit slits describe perfect circles in the slit plane. An observed spectral resolution of 125 000 in visible light is reported with slits which are 10 cm long and have a 20 cm radius of curvature in a spectrometer of 2·25 m focal length. Application to other optical systems is discussed and the relationship between the radius of curvature of the slit and the optical arrangement is presented. A.

535.33.07

2251. A simple device for direct-recording spectrophotometry. R. C. NELSON AND R. JENKINSON. *J. Opt. Soc. Amer.*, **43**, 1181–3 (*Dec.*, 1953).

A single-detector, two-beam device is described in which compensation for changes in energy and detector sensitivity is achieved by using one of the signals from the detector, a photomultiplier, to adjust the working voltage on the multiplier so as to maintain the unobstructed measuring signal constant. A.

535.33.07

2252. Noise filter effects in recording spectroscopes. S. BRODERSEN. *J. Opt. Soc. Amer.*, **43**, 1216–20 (*Dec.*, 1953).

The magnitude of the noise present in the signal from a spectroscope depends strongly upon the frequency-band-pass width of the amplifier. It is, therefore, possible to reduce the noise by inserting a low-pass filter. At the same time a distortion is produced in the spectrum recorded. It is shown for two different kinds of filter that this distortion may be divided into two effects: (1) a displacement of the spectrum as a whole, which is easily corrected for, and (2) a real distortion depending upon the width of the spectral lines. It is shown that the only means to limit this distortion is to scan the spectrum at a sufficiently low speed. An expression is given for this speed, which is proportional to the width of the narrowest line (often equal to the effective slit-width), and inversely proportional to the time-constant of the filter and to a constant characterizing the maximum tolerable distortion. A.

535.33.07 : 551.593.9

A new method of observing the atmospheric emission from the *D*-lines of sodium. *See Abstr.* 2960

535.33.07–14

2253. A microwave spectroscope and a review of microwave spectroscopy. B. BAK. *Trans Instrum. Meas. Conf.*, **1952**, 8–14.

The Hughes–Wilson method of observing dipole moments as small as 0·1 Debye by the use of the Stark effect is described. Crystal-controlled wavemeters can give accuracies of 1 in 10^6 with ease. Microwave spectroscopy makes possible a study of "fine structure," it forms a sensitive analytic tool. Solids and liquids with vapour pressures $<10^{-3}$ mm Hg cannot be studied. W. T. BLACKBAND

535.33.07–15

2254. A high dispersion vacuum grating spectrograph for the infra-red. H. H. NIELSEN. *Trans Instrum. Meas. Conf.*, **1952**, 47–51.

Describes briefly an instrument with a Littrow fore-prism monochromator used with a Pfund-mounted plane grating up to 20×25 cm area and with concave mirrors of dia. 25 cm and focal length 100 cm. The radiation is chopped at 13 c/s and the output of the detector (PbS cell or thermopile) is fed to an amplifier and recording potentiometer. Resolution is said to be good (a recording of the 1·4 μ water vapour band is shown); it is hoped to obtain still better resolution by increasing the time constant of the amplifier. G. F. LOTHIAN

535.338 : 538.615

2255. Studies of patterns of strong Paschen–Back interaction. M. L. ESPINOSA. *An. Real. Soc. Españ. Fís. Quim.*, **48**(A) 211–18 (*July–Aug.*, 1952) *In Spanish.*

The eigenvalue equation of the magnetic levels belonging to a spectral term is stated in order to study Zeeman patterns of Mn I with partial Paschen–Back effect. Having calculated the magnetic field, in spectrograms of Mn I obtained at Massachusetts Institute of Technology, the computation was made of the patterns of the $z^6P^0 \rightarrow e^6D$ multiplet of Mn I. These patterns were measured and the resulting values compared with the calculated values. The existence of some forbidden components is noted. A.

535.338 : 538.615

2256. Calculation of strengths in patterns of strong Paschen-Back interaction. M. L. ESPINOSA. *An. Real. Soc. Españ. Fís. Quim.*, **48**(A) 219–22 (*July–Aug.*, 1952) *In Spanish.*

The expression that gives the strength of the magnetic components in percentage of the line strengths is stated. Theoretical principles of computation of line strengths in Paschen–Back patterns in *L-S* coupling are considered in order to deduce a general expression for the component strengths and to explain the existence of forbidden components. A.

535.338 : 538.615

2257. Interaction of multiplets with strong Paschen–Back interaction. M. L. ESPINOSA. *An Real. Soc. Españ. Fís. Quim.*, **48**(A) 223–32 (*July–Aug.*, 1952) *In Spanish.*

Conditions for the interpretation of the multiplets

are given. Theoretical patterns for lines in the $z^6P \rightarrow e^6D$ multiplet of Mn I, with a magnetic field of 85 000 Oe, agree with experimental data. Twenty-two forbidden components, accurately observed, have been classified. The state of the *L-S* coupling in magnetic levels of the z^6P and e^6D terms of Mn I is also considered. Experimental *g*-values for those levels have been computed; the *g*-permanence rule is verified. A.

535.338 : 538.615

2258. Interpretation of the multiplet $a^6S \rightarrow z^6P$ of Mn I in magnetic field of the order of 85 000 oersted. M. L. Espinosa. *An. Real. Soc. Españ. Fis. Quim.*, **48**(A) 267–70 (*Sept.–Oct.*, 1952) *In Spanish.*

Thirty-five components were measured, permitting the interpretation of this multiplet in full agreement with some previous conclusions. A.

535.338 : 538.615

2259. The interference of the enforced electric dipole radiation and the spontaneous electric quadrupole radiation. J. Dąbrowski. *Acta phys. Polon.*, **11**, *No.* 2, 131–9 (1952).

The case is investigated when the magnetic field is parallel to the electric field, the latter enforcing the dipole radiation. The result of the calculation is that the interference effect can be expected to be observable in transversal observation. Placing a nicol askew, we can obtain such a position that one of the $\Delta M = \pm 1$ components is extinguished. Then, the intensity of the corresponding $\Delta M = \mp 1$ component gets its maximum. Approximate formulae for the intensity of the Zeeman components are given in the case of Russell–Saunders coupling. Their application to the first line of the ${}^3D_{5|2,3|2} \rightarrow {}^2S_{1/2}$ series in the potassium spectrum leads to the conclusion that in this case one must apply an electric field of about 10 kV/cm to observe the interference effect. A.

535.338–31

2260. New atomic energy levels in the second spectrum of iron (Fe II). M. Sales. *An. Real. Soc. Españ. Fis. Quim.*, **49**(A) 15–30 (*Jan.–Feb.*, 1953) *In Spanish.*

New measurements in the region 1260 to 2234 Å of the vacuum spark spectrum of iron have been made. In the Fe II spectrum 36 new atomic energy levels (8 even and 28 odd) have been identified. All the even levels are arranged into 6 even terms, and 27 of the odd levels to 12 odd terms. The new terms belong to electronic configurations: $3d^65s$, $3d^64p$, $3d^64d$ and $3d^54s4p$. Configurations for some previously known terms have also been assigned. A list with 300 lines, now classified, is given. A.

535.338.1

2261. Series and ionization potentials in the spectra I, II and III of the elements of the iron group. M. A. Catalán and R. Velasco. *An. Real Soc. Españ. Fis. Quim.*, **48**(A) 247–66 (*Sept.–Oct.*, 1952) *In Spanish.*

The lowest levels, high and low multiplicity, of $3d^{n-1}4s$ and $3d^{n-1}5s$, in spectra K I to Cu I, Ca II to Zn II and Sc III to Ti III are compared. The distances $5s$–$4s$ increase with Z, step by step, in the high multiplicity, but a sharp discontinuity appears in the middle of the groups (Cr I, Mn II or Fe III) in the low multiplicity. Using the accurate values of terms given by Russell, for spectra Ca II to Zn II, values for Rydberg denominators and constant α of Ritz formula are computed. The denominators change similarly to the distances $5s$–$4s$ but the curves for α-values run without any discontinuity. Using the few spectra I and III for which values of terms were accurately known and following the expected analogy with spectra II, curves for denominators and α-values have been drawn. These curves have permitted accurate estimation of values for the other elements of the groups. Ionization potentials, calculated by means of the respective term values, are also given. The shape of the curves shows clearly that the convergency of the series is of the normal type of Hund for the first half of the periods, but that it is of the inverted type for the second half. A.

535.338.1

2262. Series and ionization potentials in the spectra I and II of the elements of the palladium group. M. A. Catalán and F. R. Rico. *An. Real. Soc. Españ. Fis. Quim.*, **48**(A) 328–38 (*Nov.–Dec.*, 1952) *In Spanish.*

The structural data known at present for the configurations $4d^{n-1}5s$ and $4d^{n-1}6s$ in spectra Rb I, Sr I, Pd I, Ag I, Sr II and Cd II suggest the possibility of extending the relations found by Catalán and Velasco [see previous abstract] for the iron group, to the palladium group. Following the analogy, and using the existing experimental data, curves have been drawn for: the distances between terms $6s$ and $5s$, Rydberg denominators, α-values of the Ritz constant and separations between Rydberg denominators, for high and low multiplicity, in $5s$ and $6s$. The values of the limits of the series were adjusted in order that all the curves run smoothly. Only a few points fall out of these curves showing that the corresponding terms are probably perturbed by interactions. From the adjusted limits, values of the ionization potentials, for spectra Rb I to Ag I and for Sr II to Cd II, were deduced. A.

535.338.1

2263. The electron levels $3d^{n-2}4s^2$ and $3d^{n-2}4s5s$ in the elements of the first transition group. M. A. Catalán. *An. Real. Soc. Españ. Fis. Quim.*, **49**(A) 67–76 (*March–April*, 1953) *In Spanish.*

The lowest levels, high, middle and low multiplicity, of $3d^{n-2}4s^2$ and $3d^{n-2}4s5s$, in spectra Ca I to Zn I are compared. The spectral series are designated type *C* or *D* according as they converge in a term of higher or lower multiplicity than the multiplicity of their own terms. The distances $5s$–$4s$ between levels increase with *Z*, step by step, for type *C*, but a sharp discontinuity appears in the middle of the period (Mn I) in the type *D*. Using the values of ionization potentials recently computed by Catalán and Velasco, values for terms, Rydberg denominators and α-constant of Ritz formula have been calculated for the series $3d^{n-2}4s^2$–$4s5s$. With these values several curves have been drawn. The curves of terms and denominators run continuously in series of type *C*, but a sharp discontinuity appears, in the middle of the period, in cases of type *D*. The values give a concave or a convex curve for types *C* or *D* respectively. These conclusions are valid for the

configuration $3d^{n-1}4s$–$5s$. The shape of the curves shows clearly that the convergency of the series is of normal type of Hund for all elements of the period. A.

535.338.1

2264. Laboratory ionic-impact emission spectra. C. Y. Fan and A. B. Meinel. *Astrophys. J.*, **118**, 205–13 (*Sept.*, 1953).

A spectrographic study was made of the optical emissions from a rarefied air sample under the bombardment of protons (40–230 keV), deuterons (75–320 keV), He^+ ions (150–450 keV) and Ne^+ ions (400 keV). It was found that the ratio of intensity between the N II and N_2^+ emissions is approximately independent of the energies of the bombarding particles but strongly dependent upon the species of particle. As a consequence it is found to be possible to distinguish between protons and heavy ions by the spectrum produced, even when emissions from the exciting particle are absent. This discovery has made it possible to estimate the ratio of protons to heavies in the primary particle beam producing the aurora borealis. A.

535.338.1 : 535.343.4

2265. Pre-ignition and flame spectra in the self-combustion of acetylene. W. W. Robertson, N. B. Humphrey and R. C. Anderson. Letter in *J. chem. Phys.*, **21**, 2093–4 (*Nov.*, 1953).

The emission spectrum of the self-combustion flame, taken over the visible and u.v. range, was continuous from 3500 to 6000 Å, with a maximum at 5800 Å. Absorption spectra were taken at pre-ignition temperatures (375–500°c) and showed a continuum that started in the u.v. and extended into the visible when the cell temperature was raised. Acetylene was diluted with helium for spectra taken at higher temperatures (up to 1000°c). These spectra were also continuous but the absorption extended to longer wavelengths. No C_2 or CH bands were observed, so the concentrations of these radicals must be low, if they are formed at all. A. J. Taylor

535.338.3 : 537.523.4

The spectrum of predischarges in very long sparks. *See Abstr.* 2452

535.338.332 : 539.152.2

2266. The hyperfine structure anomaly of silver. E. Brun and H. H. Staub. *Helv. phys. Acta*, **26**, *No.* 7–8, 821–7 (1953) *In German.*

The recent very accurate measurements of the h.f.s. splitting and the nuclear magnetic moments of the two stable silver isotopes 107 and 109 give a value of the h.f.s. anomaly of 0·413%. Calculations of this anomaly are made on the basis of various nuclear models. It is found that the two single particle models of Bloch, de Shalit and Miyazawa and of Davidson lead to the best agreement, viz. 0·41 and 0·44% resp. A.

535.338.4

2267. On the band-spectrum of silver oxide. U. Uhler. *Ark. Fys.*, **7**, *Paper* 12, 125–47 (1953).

A rotational analysis of two band-systems of AgO was carried out. The transitions are $A^2\Pi - X^2\Pi$ and $B^2\Pi - X^2\Pi$: the heads of the 0, 0 bands (cm^{-1}) are as follows: $A^2\Pi_{\frac{3}{2}} - X^2\Pi_{\frac{3}{2}}$ 24 416·0, $A^2\Pi_{\frac{1}{2}} - X^2\Pi_{\frac{1}{2}}$ 24 244·5, $B^2\Pi_{\frac{3}{2}} - X^2\Pi_{\frac{3}{2}}$ 28 137·5, $B^2\Pi_{\frac{1}{2}} - X^2\Pi_{\frac{1}{2}}$ 28 094·3. The value of A, the coupling constant in $X^2\Pi$ is estimated to be about $+135\ cm^{-1}$: all three doublet states are regular. The state $A^2\Pi$ is predissociated. The following constants are derived:

		ω_e	$x_e\omega_e$	
B	$^2\Pi_{\frac{3}{2}}$	539·1	6·2	$B_0 = 0·3195$
	$^2\Pi_{\frac{1}{2}}$	535·7	6·3	—
A	$^2\Pi_{\frac{3}{2}}$	$\Delta G_{\frac{1}{2}} = 241·0$		$B_0 = 0·2816$
	$^2\Pi_{\frac{1}{2}}$	$\Delta G_{\frac{1}{2}} = 237·2$		$B_0 = 0·2811$
X	$^2\Pi_{\frac{3}{2}}$	490·6	2·9	$B_v = 0·3025 - 0·0025_5 u$
	$^2\Pi_{\frac{1}{2}}$	490·2	3·1	$B_v = 0·3020 - 0·0025 u$
		$r_e(X^2\Pi_{\frac{1}{2}}) =$		2·003 Å.

The rotational constants above refer to $Ag^{107}O$. Earlier conclusions of Loomis and Watson [*Phys. Rev.*, **48**, 280 (1935)] about these systems are incorrect. R. F. Barrow

535.338.4

2268. On the band spectrum of calcium chloride. M. Schütte. Note in *Naturwissenschaften*, **40**, *No.* 20, 528 (1953) *In German.*

Three new violet-degraded band-systems ascribed to CaCl have been observed in emission in the region 4600–5500 Å. The transitions are $F(^2\Pi) - A(^2\Pi)$ with $\nu_{0,0}$ at 19 567, 19 612 cm^{-1}, $F(^2\Pi) - B(^2\Sigma)$ with $\nu_{0,0}$ at 18 858, 18 880 cm^{-1} and $G(^2\Delta) - A(^2\Pi)$ with $\nu_{0,0}$ at 20 578, 20 643 cm^{-1}. The values of ω_e and of $x_e\omega_e$ for states F and G are respectively: 432·5 and 0·8, 434 and 1·1 cm^{-1}. R. F. Barrow

535.338.4

2269. The complex band spectrum of nickel bromide (NiBr). V. G. Krishnamurty. *Indian J. Phys.*, **26**, 429–41 (*Sept.*, 1953).

The band spectrum from 3900 to 5000 Å was obtained in emission using a heavy current discharge from a 2 kW, d.c. generator. The bands are line-like and are slightly degraded to the red. As in NiCl, two electronic transitions of the type $^4\Pi - {}^4\Sigma$ designated as α and β have been identified with a common ground state of vibrational frequency $\omega_e'' = 313$. Another system is also identified and designated as γ. The vibrational formula for the heads of this system is $\nu = 21\,790·7 + 294·9\,u' - 0·80\,u'^2 - 317·2\,u'' + 0·50\,u''^2$. Besides these three systems, some other systems have also been observed. A.

535.338.4

2270. The emission spectrum of acetaldehyde in dynamical form. S. Régnier. *C.R. Acad. Sci.* [*Paris*] **237**, 1152–4 (*Nov.* 9, 1953) *In French.*

An extension of earlier work [Abstr. 4231 (1952)]. The spectrum emitted by a gaseous current of acetaldehyde subjected to a discharge of frequency 25 Mc/s was studied in the region 3700 to 4400 Å. The experimental procedure was varied in several ways to produce modifications in the intensities of the different systems of bands forming this complex region. The spectrum was compared with that produced by CO_2 under the same conditions. The region studied is formed mainly by CO^+ and CH bands though certain bands cannot be identified. An almost perfect analogy exists between the CO^+ and CO bands of acetaldehyde and CO_2. It is concluded that since the

spectrum emitted depends more upon the conditions of excitation than upon the emitting molecule itself, the method is not suited to a study of the mode of decomposition. The spectrum of the decomposition of acetaldehyde by pyrolysis, also studied, is exactly the same as that of the non-decomposed molecule.

H. H. GREENWOOD

535.338.4 : 551.593.9

2271. Intensities in the Herzberg system of O_2. M. E. PILLOW. Note in *Proc. Phys. Soc.* [*London*] *A*, **66**, 1064–5 (*Nov.*, 1953).

The vibrational intensity distribution is recalculated using the revised v' assignment necessitated by Broida and Gaydon's observation of the bands in emission in an oxygen afterglow. The agreement between calculations and the afterglow and the night-sky is good. A. G. GAYDON

535.338.4–31

2272. The ultra-violet spectrum of a diatomic hydride excited in hydrogen-potassium fluoride hollow-cathode discharges. R. F. BARROW AND A. D. CAUNT. *Proc. Phys. Soc.* [*London*] *A*, **67**, 68–73 (*Jan.*, 1954).

A many-lined spectrum in the region 2200 to 2600 Å has been obtained in hollow-cathode discharges in hydrogen in the presence of potassium fluoride. A rotational analysis has shown this to be a $v' =$ constant progression of a Σ–Σ transition, probably singlet. The emitter has not been identified. A.

535.338.42

2273. Vibrational transition probabilities of diatomic molecules: collected results N_2, N_2^+, NO, O_2^+. W. R. JARMAIN, P. A. FRASER AND R. W. NICHOLLS. *Astrophys. J.*, **118**, 228–33 (*Sept.*, 1953).

Arrays of approximate vibrational transition probabilities, i.e. $p(v', v'') =$ (overlap integral)^2 are presented for the following transitions: $N_2 : B^3\Pi_g \rightarrow A^3\Sigma_u^+$ (first positive), $C^3\Pi_u \rightarrow B^3\Pi_g$ (second positive); $A^3\Sigma_u^+ \rightarrow X^1\Sigma_g^+$ (Vegard–Kaplan); $N_2^+ : B^2\Sigma_u^+ \rightarrow X^2\Sigma_g^+$ (first negative); NO : $A^2\Sigma^+ \rightarrow X^2\Pi$ (γ-bands); O_2^+ : $A^2\Pi_u \rightarrow X^2\Pi_g$ (second negative). The methods employed in computation of these values are indicated. A.

535.338.42 : 535.375.51 : 539.132

The vibration spectra of helical molecules: infra-red and Raman selection rules. *See Abstr.* 2649

535.338.42 : 539.132

2274. Vibration-rotation bands of OH. R. C. HERMAN AND G. A. HORNBECK. *Astrophys. J.*, **118**, 214–27 (*Sept.*, 1953).

The (4–0) sequence of the vibration-rotation bands of OH have been observed in the emission spectra of various oxy-hydrocarbon flames as well as the oxy-hydrogen flame. A set of molecular constants was determined from the (4–0), (5–1) and (6–2) bands taken together with the latest ultraviolet data of Dieke and Crosswhite. The constants obtained are as follows: $B_e = 18{\cdot}867\ \text{cm}^{-1}$; $\omega_e = 3734{\cdot}09\ \text{cm}^{-1}$; $\alpha_e = 0{\cdot}708\ \text{cm}^{-1}$; $\omega_e\chi_e = 82{\cdot}66\ \text{cm}^{-1}$; $\gamma_e = 0{\cdot}00207\ \text{cm}^{-1}$; $\omega_e y_e = 0{\cdot}094\ \text{cm}^{-1}$. In addition are given values of the coupling constant, lambda doubling and band origins up to $v = 6$, as well as tables of the rotational and vibrational energy levels for $v = 4$, 5 and 6. These data should prove useful in predicting accurately the positions of some of the vibration-rotation lines of OH which are of astrophysical interest. A.

535.338.42 : 539.132

2275. Infrared emission of the hydrogen-fluorine (H_2–F_2) flame. W. S. BENEDICT, B. W. BULLOCK, S. SILVERMAN AND A. V. GROSSE. *J. Opt. Soc. Amer.*, **43**, 1106–13 (*Nov.*, 1953).

This was studied with prism resolution in the fundamental, as well as in the first and second overtone regions. Flame temperatures of approximately 4000°K are estimated from the spectroscopic data, and although due to insufficient resolution and difficulties of self-absorption, it is not possible to determine whether there is equipartition of energy between vibrational and rotational modes of excitation. However, the present experiments, together with previous high resolution absorption studies, do permit new and improved values of the molecular constants to be determined, namely, $B_0 = 20{\cdot}569\ \text{cm}^{-1}$, $\alpha = 0{\cdot}751\ \text{cm}^{-1}$, $D_0 = 2{\cdot}42 \times 10^{-3}\text{cm}^{-1}$, $v_1 = 3961{\cdot}31\ \text{cm}^{-1}$ and $v_2 = 7751{\cdot}84\ \text{cm}^{-1}$. A.

535.338.42–15 : 539.132

2276. Rotation-vibration spectra of diatomic and simple polyatomic molecules with long absorbing paths. XI. The spectrum of carbon dioxide (CO_2) below 1·25 μ. G. HERZBERG AND L. HERZBERG. *J. Opt. Soc. Amer.*, **43**, 1037–44 (*Nov.*, 1953).

The spectrum of CO_2 in the photographic infrared was studied with absorbing paths up to 5500 m. Thirteen absorption bands were found of which eleven have been analysed in detail. One of these is due to $C^{13}O_2$. From the band origins of the $C^{12}O_2$ bands improved values for some of the anharmonic constants of the molecule have been derived. The study of the rotational structure of the photographic infrared CO_2 bands has yielded considerably improved values for the rotational constants. The new values are $B_{000} = 0{\cdot}3902_0\ \text{cm}^{-1}$, $\alpha_1 = +0{\cdot}00109$, $\alpha_2 = -0{\cdot}00073$, $\alpha_3 = +0{\cdot}00307\ \text{cm}^{-1}$. From these the following equilibrium values of rotational constant, moment of inertia and internuclear distance are obtained: $B_e = 0{\cdot}3915_5\ \text{cm}^{-1}$, $I_e = 71{\cdot}46_8 \times 10^{-40}\ \text{gm cm}^2$, $r_e = 1{\cdot}1600_5 \times 10^{-8}\ \text{cm}$. By taking account of the effect of Fermi resonance, excellent agreement of the observed $B_{[v]}$ values with those calculated from the α_i and B_e is obtained. The l-type doubling in the states 01^10, 11^13 and 03^13 has been determined. The agreement of the splitting constants q with those obtained from theory is satisfactory. A.

535.338.42–15 : 539.132

2277. Vibration bands and molecular rotational constants of nitrous oxide. H. W. THOMPSON AND R. L. WILLIAMS. *Proc. Roy. Soc. A*, **220**, 435–45 (*Dec.* 22, 1953).

Seven vibration-rotation bands of nitrous oxide have been measured with high resolution. The rotational fine structure of each has been analysed and rotational constants have been derived. The value for B_{000} found from four bands is $0{\cdot}4190_1\ \text{cm}^{-1}$, agreeing very closely with that determined from the microwave spectrum. Values for the coefficients α_i for the different vibrational levels have been determined, and the occurrence of inconsistencies in the calculated values of $B_{v_1v_2v_3}$ for higher vibrational

levels confirms previous suggestions that resonance interactions may exist between different levels. Such interactions appear also to disturb the positions of the band origins. A.

535.34 : 537.311.3

On the theory of optical absorption in metals and semiconductors. *See Abstr.* 2418

535.343

2278. Change of frequency of resonance lines of sodium during transmission through sodium vapour. G. S. Kastha. *Indian J. Phys.*, **27**, 67–72 (*Feb.*, 1953).

The structure of the *D*-lines of sodium filtered through an absorption cell containing sodium vapour at temperatures ranging from 465°K to 563°K and pressures ranging from $8{\cdot}4\times10^{-5}$ to $9{\cdot}1\times10^{-3}$ mm of Hg were studied using a 12 ft concave grating spectrograph in its third order. It was observed that at lower temperatures and pressures the transmitted *D*-lines appear as doublets owing to the absorption of the central part and that as the pressure is increased the distance between the components of each doublet increases rapidly, so that at a pressure of $9{\cdot}1\times10^{-3}$ mm the distance from resonance is $1{\cdot}13\ \text{cm}^{-1}$ for D_1 and $1{\cdot}58\ \text{cm}^{-1}$ for D_2. It is pointed out that in the incident radiation filtered through Hg vapour at a pressure of about 10^{-4} mm of Hg, there is no intensity at these distances from resonance and therefore this alteration in frequency takes place in a process of absorption of the quantum just before collision and its re-emission at the instant of collision. A.

535.343

2279. A discussion on the spectroscopic state of tetravalent carbon in the halogen substituted derivatives of methane, as revealed by absorption spectra. P. K. Sen Gupta. *Indian J. Phys.*, **27**, 149–54 (*March*, 1953).

The view that tetravalent carbon in the halogen substituted derivatives of methane has the electronic configuration $1s^2\ 2s^2\ 2p^2\ (^3P\ ^1D\ ^1S)$ is supported by a comparison of energy values corresponding to the first long wavelength limit of continuous absorption in these compounds with the values of energy of carbon-halogen bond calculated with the aid of thermochemical data. In the calculations the latent heat of sublimation of graphite recently proposed by the author has been utilized. A.

535.343 : 535.375.5 : 539.132

2280. Infrared and Raman spectra of tetramethylmethane-d_{12}. E. R. Shull, T. S. Oakwood and D. H. Rank. *J. chem. Phys.*, **21**, 2024–9 (*Nov.*, 1953).

In order to study further the molecular vibrations of tetramethylmethane and of hydrocarbons in general, tetramethylmethane-d_{12} was synthesized and its Raman and infrared absorption spectra were obtained. The missing non-degenerate mode, $\nu_2(a_1)$, in ordinary tetramethylmethane was predicted by the Teller–Redlich product rule to lie about $1430\ \text{cm}^{-1}$ where it would be obscured by a strong depolarized Raman band at $1451\ \text{cm}^{-1}$. A unique narrowness in the $1200\ \text{cm}^{-1}$ infrared absorption bands of tetramethylmethane and tetramethylmethane-d_{12} and double maxima of small separation in the band of tetramethylmethane resulted in assigning these frequencies to methyl wagging modes of unsymmetrical character. The over-all results of this investigation cast doubt on the validity of extending theoretical considerations of tetrahedral XY_4 systems to the tetrahedral tetramethyl molecules with the assumption of the methyl groups as point masses. A.

535.343 : 539.132

2281. The absorption spectrum of bismuth oxide. N. K. Bridge and H. G. Howell. *Proc. Phys. Soc.* [*London*] *A*, **67**, 44–51 (*Jan.*, 1954).

The absorption spectrum produced when bismuth is heated in a furnace up to 1500°C has been analysed. It extends from 2450 Å to 3800 Å. Evidence is given to attribute it to the diatomic molecule BiO. The bands are grouped into four systems and there is evidence of a fifth. The vibrational constants proposed for these systems are:

ν_e	ω_e	$x_e\omega_e$
40930	770	
38551·8	769·3	6·2
30500	—	
30220	487	
28739·5	487·0	6·5
0	695·9	4·9

The ground state is considered to be the lower component of a case $a\ ^2\Pi$, with probable ω–ω coupling and the doublet splitting is estimated to be between the limits 8000 and $13\,500\ \text{cm}^{-1}$. The relation of the absorption spectrum to the emission spectrum is considered and an attempt is made to account for the energy levels in terms of electron configurations. A.

535.343 : 541.14 : 541.127

Triplet states in solution. *See Abstr.* 2810

535.343–12

2282. Pure quadrupole spectra of some nitrochlorobenzenes. T. L. Weatherly and Q. Williams. Letter in *J. chem. Phys.*, **21**, 2073–4 (*Nov.*, 1953).

535.343–14/15 : 539.133

2283. Comparison of the results of infrared and centimetre spectroscopy. J. Duchesne. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 270–6 (1952) *In French.*

The advantages and limitations of the two methods for the measurement of bond lengths are discussed and the determination of dipole moments and quadrupole couplings from centimetre-wave spectroscopy is outlined. D. H. Whiffen

535.343–14

2284. Spectroscopy near the boundary between the microwave and infrared regions. A. H. Nethercot, J. A. Klein, J. H. N. Loubser and C. H. Townes. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 358–63 (1952).

The application of crystal doubling to obtain waves down to 1·1 mm is described and absorption in the high frequency tail of the NH_3 band is compared with the van Vleck–Weisskopf line shape and found to require slightly different line breadth parameters from the lower frequency measurements. The inversion of excited $(\nu_1 = 1)ND_3$ is observed at 117 000 Mc/s. Comparison of HCN B_{000} value, 44 315·9 Mc/s with the infrared value gives $c = 299\,776 \pm 4$ km/sec which is in slight disagreement with the accepted value. D. H. Whiffen

535.343–14 : 537.226.3

2285. Absorption in the Hertzian spectrum of free water and bound water. Orientation of the molecules and crystal defects. R. FREYMANN. *J. Chim. phys.*, **50,** C 26–C 34 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids" colloquium [see Abstr. 2866 (1954)]. A review of the work at Rennes on the microwave and lower frequency problems in dielectrics, dealing particularly with the determination of free and bound water from the dielectric loss, questions about lattice defects and the $\log \nu_c - 1/T$ representation. D. H. WHIFFEN

535.343–14 : 539.133

2286. Microwave spectrum of pyridine. K. E. MCCULLOH AND G. F. POLLNOW. Letter in *J. chem. Phys.*, **21,** 2082 (*Nov.*, 1953).

In a new measurement of 124 lines, 31 Q-transitions and 3 R-branches have been assigned; the dipole moment being along the least inertia axis. The asymmetry parameter was $\kappa = 0{\cdot}84777$, and centrifugal distortion was taken into account; the symmetry group c_{2v} was deduced. Excellent agreement between calculated and observed frequencies was thus achieved. [See also Abstr. 7573 (1953)]. J. JACOBS

535.343–15

2287. Infrared spectrum of CH_2D–CH_2D at high dispersion. R. VAN RIET, C. COURTOY AND M. DE HEMPTINNE. *Ann. Soc. Sci. Bruxelles, I,* **67,** *No.* 2, 105–21 (1953) *In French.*

Absorption curves are given for the region 700–3030 cm^{-1}. Parallel type bands can be allocated to the 2 possible isomers, but for other bands there is a discrepancy between experimental and calculated rotational constants. G. F. LOTHIAN

535.343–15

2288. Infrared spectrum of cis- and trans-$C_2H_2D_2$ at high dispersion. J. CHARETTE, C. COURTOY AND M. DE HEMPTINNE. *Ann. Soc. Sci. Bruxelles, I,* **67,** *No.* 2, 122–39 (1953) *In French.*

Absorption curves for the mixture are given for the region 700–3160 cm^{-1}. If the molecule is considered as a symmetrical top, calculations of rotational lines agree with measured values to a first approximation. G. F. LOTHIAN

535.343–15

2289. The infrared spectrum of nitric acid monohydrate. D. E. BETHELL AND N. SHEPPARD. *J. Chim. phys.*, **50,** C 72–C 74 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. The liquid spectrum is very similar to that of HNO_3, but the solid spectrum has bands at 1·134 and 1·670 cm^{-1} due to H_3O^+. From its similarity with NH_3 it is plausible that these bands belong to ν_2 and ν_4 vibrations. Other vibrations similar to those of NH_3 may also be present. C. TURNER

535.343–15 : 539.132

2290. Vibrational spectra of fluorinated aromatics. VII. 1,2,4-trifluorobenzene. E. E. FERGUSON, R. L. HUDSON, J. R. NIELSEN AND D. C. SMITH. *J. chem. Phys.*, **21,** 1727–30 (*Oct.*, 1953).

For Pt VI, see Abstr. 269 (1954). The infrared absorption spectrum of liquid 1,2,4-trifluorobenzene has been obtained in the region 2–38 μ with the aid of LiF, NaCl, KBr and KRS-5 prisms. The Raman spectrum of the liquid has been photographed with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å, and depolarization ratios have been measured for the stronger Raman bands. A complete assignment of fundamental vibration frequencies is given and the spectra are interpreted in detail. A.

535.343–15 : 539.132

2291. Vibrational spectra of fluorinated aromatics. VIII. 1,4-bis (trifluoromethyl) benzene. E. E. FERGUSON, L. MIKKELSEN, J. R. NIELSEN AND D. C. SMITH. *J. chem. Phys.*, **21,** 1731–5 (*Oct.*, 1953).

The infrared absorption of liquid 1,4-bis (trifluoromethyl) benzene has been obtained in the region 2–22 μ with the aid of LiF, NaCl and KBr prisms. The Raman spectrum has been photographed with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å. A nearly complete assignment of fundamental vibration frequencies is given and the spectra are interpreted in detail. A.

535.343–15 : 539.132

2292. Vibrational spectra of fluorinated aromatics. IX. *p*-fluorotoluene. E. E. FERGUSON, R. L. HUDSON, J. R. NIELSEN AND D. C. SMITH. *J. chem. Phys.*, **21,** 1736–40 (*Oct.*, 1953).

The infrared absorption spectrum of liquid *p*-fluorotoluene has been obtained in the region 2–38 μ with the aid of LiF, NaCl, KBr and KRS-5 prisms. The stronger bands of the gas phase have been scanned with NaCl and KBr prisms. The Raman spectrum of the liquid has been photographed with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å. A complete assignment of fundamental vibration frequencies is given and the spectra are interpreted in detail. A.

535.343–15 : 539.2

2293. The infrared spectrum and the study of water in solids. *J. Chim. phys.*, **50,** C 53–C 71 (*Sept.*, 1953). *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)].

I: General introduction and formulation of the problem. J. LECOMTE (C 53–C 64.)

Gives a review of the work done on the infrared absorption spectrum of water (solid, liquid and vapour). Comparison of the bands in the 3 states shows how water molecules are bonded together. The absorption spectrum of molecules containing one or more OH-groups is reviewed briefly. For hydrated crystals a review is given of papers relating the molecular vibrations of water and bonding forces of water molecules with the anhydride structure to the spectrum, and of those attempting to place the water molecules in the crystal structure.

II: Some experimental determinations. J. LECOMTE AND C. DUVAL (C 64–C 71).

Measurements on halogenides; 20 products obtained by treating a copper salt with a base; calcium sulphates; minerals containing water of crystallization; OH-groups, etc. Some measurements on the modification of molecular symmetry by different degrees of hydration. An extensive literature list is given. C. TURNER

535.343–15 : 548.0

2294. Infrared studies of the OH-bands of crystals. A. M. VERGNOUX. *J. Chim. phys.*, **50**, C 75–C 76 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. Absorption and birefringence measurements up to 3 microns on mica give some idea of the orientation of the OH-oscillation in the crystal lattice. C. TURNER

535.343–31

2295. On the electronic spectra of dibenyzl, diphenylmethane and ethylbenzoate in the solid state at −180°C. A. R. DEB. *Indian J. Phys.*, **27**, 183–90 (*April*, 1953).

The ultraviolet absorption spectra of $(C_6H_5CH_2)_2$, $C_6H_5CH_2C_6H_5$ and $C_6H_5COOC_2H_5$ in the liquid and solid states at different temperatures were photographed using very thin films of the substances, and the observed bands have been analysed. Dibenyzl in the liquid state yields eight bands with the ν_0 band at 37 122 cm^{-1} and the other bands corresponding to vibrational frequencies 564, 990 and 1283 cm^{-1}. These vibrational frequencies diminish slightly in the case of the solid at 30°C. In the case of the solid at −180°C, however, the bands are found to be sharper and more numerous. The vibrational frequencies at −180°C are a little larger than the corresponding frequencies at 30°C, but smaller than those observed in the case of the liquid at 80°C. In the case of diphenylmethane in the liquid state only six bands with the ν_0 band at 36 984 cm^{-1} and other bands corresponding to vibrational frequencies 1008 and 1384 cm^{-1} are observed. In the solid state at −180°C the substance yields 17 bands with the ν_0 band at 36 821 cm^{-1} and other bands corresponding to vibrational frequencies 593, 932, 1370 and 1592 cm^{-1}. In the case of ethylbenzoate in the liquid state only three bands with the ν_0 band at 35 596 cm^{-1} are observed. The solid at −180°C also yields three bands with ν_0 band shifted to 35 500 cm^{-1}. The bands are broad in both these states. In the vapour state several bands with ν_0 band at 36 136 cm^{-1} and other bands corresponding to vibrational frequencies 312, 546 and 917 cm^{-1} were observed. All these results are discussed in detail. A.

535.343–31

2296. The ultraviolet absorption spectra of organic substances in the liquid and solid states. IV. Chlorotoluenes. H. N. SWAMY. *Indian J. Phys.*, **26**, 445–51 (*Sept.*, 1952).

For Pt III, see Abstr. 3125 (1953). *o*- and *m*-chlorotoluene in the vapour, liquid and solid states and of *p*-chlorotoluene in the liquid and solid states were investigated in order to find out the changes which may take place in the spectra with change of state. In all the cases the bands shift to longer wavelength with liquefaction by more than 250 cm^{-1} and in the case of both *o*- and *m*-chlorotoluene the principal 0, 0 band shifts by about 700 cm^{-1} towards shorter wavelength on solidification. In the case of these latter two compounds the principal band is accompanied by two fainter satellites. It is pointed out that these results may indicate formation of virtual bonds between neighbouring molecules in the solid state and that similar results reported by previous workers in the case of benzene may also indicate formation of such virtual bonds. A.

535.343–31

2297. Ultraviolet absorption bands of crystals of *ortho*- and *para*dichloro benzene and paradibromobenzene at low temperatures. H. N. SWAMY. *Indian J. Phys.*, **27**, 55–65 (*Jan.*, 1953).

For previous work, see preceding abstract. Thin films of *o*-dichlorobenzene in the liquid state at 30°C and in the solid state at −50°C and −180°C and of *p*-dichlorobenzene and *p*-dibromobenzene in the liquid state and in the solid state at 30°C and −180°C were investigated. In the latter two cases the solid films were also once cooled to −180°C and after bringing them to 30°C their absorption spectra were photographed. In the case of *o*-dichlorobenzene in the liquid state only three bands are observed with intervals of about 1030 cm^{-1}. Each of these is split up into two when the liquid is solidified at −50°C, and at −180°C each of the three bands for the liquid is split up into three bands. The intervals between the principal band and the satellites do not agree with any of the vibrational frequencies observed in the case of the vapour. It is suggested that formation of virtual bonds between neighbouring molecules may be responsible for such splitting of the electronic energy level. In the case of *p*-dichlorobenzene, the liquid as well as the crystal at 30°C yield three broad bands at intervals of about 1030 cm^{-1}. When the crystal is cooled to −180°C and again brought to room temperature three more new bands corresponding to the vibration frequency 764 cm^{-1} are observed. At −180°C, the number of bands increases owing to the appearance of other new bands corresponding to vibrational frequency 569 cm^{-1}. In the case of *p*-dibromobenzene, the solid at 30°C either before or after once being cooled to −180°C exhibits bands similar to those observed in the case of the liquid. When the solid is cooled to −180°C the bands become sharp and extra bands corresponding to vibrational frequencies 329, 537, 693, 1004, 1202 and 1431 cm^{-1} appear. The appearance of these extra bands in both the cases is assumed to be due to sharpening of the broad bands caused by the cessation of angular oscillations at −180°C. It is suggested that formation of virtual bonds may be responsible for the damping of angular oscillations at low temperatures. A.

535.343–31

2298. Absorption spectra of organic substances in the liquid and solid states. VI. Some disubstituted benzenes. H. N. SWAMY. *Indian J. Phys.*, **27**, 119–25 (*March*, 1953).

For previous work, see preceding abstracts. Spectra of ortho and para chlorophenol and bromotoluene were investigated in the liquid and solid states at different temperatures, including that of liquid oxygen. In the case of *o*-chlorophenol three bands are observed in both liquid and solid states, the ν_0 band shifting by about 270 cm^{-1} towards shorter wavelengths with solidification and cooling down to −180°C. The shift is very small in the case of liquefaction of the vapour. In the case of the

para compound the liquid state yields two broad bands while the solid state yields three bands with ν_0 band shifted by about 180 cm^{-1} towards shorter wavelengths. With liquefaction of the vapour the ν_0 band shifts towards longer wavelengths by about 150 cm^{-1}. In the case of *o*-bromotoluene in the liquid state three bands are observed with ν_0 band at 36 450 cm^{-1} and a progression of the frequency 982 cm^{-1}. The solid at −180°c yields nine bands which are explained on the assumption that the energy level splits into three components. In this case also the ν_0 band shifts by about 400 cm^{-1} towards longer wavelengths with liquefaction of the vapour and the principal component of this band shifts by about 726 cm^{-1} towards shorter wavelengths with solidification and cooling down to −180°c. In the case of *p*-bromotoluene no such splitting is observed, but the ν_0 band shifts in the same directions as in the ortho compound with liquefaction and solidification. The results have been discussed and it is pointed out that these shifts may indicate formation of virtual bonds between neighbouring molecules. A.

535.343.2 : 537.572

2299. Study of the internal ionization of solid ω-aminoacids with the aid of infrared absorption spectra. J. Despas, J. Khaladji and R. Vergoz. *Bull. Soc. Chim. France*, **20**, 1105–11 (*Nov.–Dec.*, 1953) *In French.*

Infrared spectra were taken between 3 μ and 15 μ of various organic acids, primary amines, and their chlorohydrates and acetates, in order to establish the positions of bands of the groups −COOH, $-NH_2$, $-NH_3^+$, $-COO^-$, $-NH^-$ and $-COO^-$. Then spectra of various solid amino-acids of formulae $NH_2(CH_2)_nCOOH$ (*n* being of the order 10) were investigated, and their bands compared with those of the groups mentioned. It was found that in the solid phase these amino-acids exist in the ionized form: $NH_3^+-(CH_2)_n-COO^-$. In polyamides the −CO−NH-group became more important with the degree of polymerization, but there still remained evidence of the existence of the ionized form.

A. J. TAYLOR

535.343.4

2300. Contribution to the experimental study of the absorption of ozone. E. Vigroux. *Ann. Phys.* [*Paris*] **8**, 709–62 (*Sept.–Oct.*, 1953) *In French.*

Photographic measurements have been made in the range 2300–6350 Å, and tables show, to the nearest 1 Å, the wavelengths of the maxima and minima; corresponding absorption coefficients (*E*) are tabulated for various temperatures in the range −92° to +120°c—except for the region 3696–3845 Å, where the values are too small to be measured accurately. In the ultraviolet, *E* decreases with decreasing temperature; in the visible, there is no significant temperature effect. Measurements in the infrared are made with a pen-recording prism-grating instrument, both in the laboratory and for the solar spectrum showing atmospheric O_3; wavenumbers to the nearest 0·01 cm^{-1} are tabulated for the peaks of the long wave branches of bands at 9·6 and 4·75 μ and compared with the positions calculated from 4 constant formulae chosen to fit the experimental points. *Q* branches at 3·59 and 3·27 μ have been recorded but no details are reported.

G. F. LOTHIAN

535.343.4–14

2301. Absorption of microwaves in gases. Krishnaji and P. Swarup. Letter in *J. appl. Phys.*, **24**, 1525 (*Dec.*, 1953).

Absorption coefficients at 3·06–3·44 cm, and at pressures of 20–76 cm Hg, for NH_3, C_2H_5Cl, CH_3CHO, CH_3I and $(CH_3)_2CO$. D. H. WHIFFEN

535.343.4–14 : 539.133

2302. The ultra-Hertzian spectrum of water vapour. W. Gordy. *J. Chim. phys.*, **50**, C 114–C 116 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. A review of the observed microwave absorptions of H_2O, HDO and D_2O and an explanation of the difficulties of obtaining accurate bond distances and angles therefrom. D. H. WHIFFEN

535.343.4–15 : 539.132

2303. The rotational spectrum of ND_3 between 60 and 200 K. R. E. Stroup, R. A. Oetjen and E. E. Bell. Letter in *J. chem. Phys.*, **21**, 2072–3 (*Nov.*, 1953).

Eight new lines of this spectrum are reported. Observed and calculated frequencies of these and six other lines are tabulated, the calculated being obtained from the symmetric-top formula. Two (B and D_J) of the three parameters in this formula were deduced from the spectrum by neglecting the third parameter, (D_{JK}), the components corresponding to which were not observed. D_J and D_{JK} the centrifugal stretching constants were also calculated from geometry and the force-constants. The agreement for D_J was fairly good, but that for D_{JK} was vitiated by the above approximation.

A. J. TAYLOR

535.343.4–15 : 539.132

2304. PH_2D and PHD_2 rotational lines in the region between 50 and 100 K. R. E. Stroup and R. A. Oetjen. Letter in *J. chem. Phys.*, **21**, 2092 (*Nov.*, 1953).

Spectrograms of PD_3 show alien lines, which by their regular variation seem to originate with either PH_2D or PHD_2. Samples of these spectrograms are reproduced and compared with the calculated spectrum, and the odd bands are listed, some being assigned to PH_2D, other to PHD_2. A. J. TAYLOR

535.343.4–15 : 539.133

2305. The vibration spectrum of nitrous oxide ($4\nu_2$ band). P. Barchewitz, M.-L. Grenier-Besson and G. Amat. *C.R. Acad. Sci.* [*Paris*] **237**, 1322–3 (*Nov.* 23, 1953) *In French.*

New measurements with more thorough removal of CO_2 give a modified value of 2322 cm^{-1} for the $4\nu_2$ band, which corrects the value obtained earlier [Abstr. 7581 (1953)] and which agrees with the calculated 2315 cm^{-1}. G. F. LOTHIAN

535.371

2306. The role of oxygen in ZnS–Cu phosphors. E. Grillot. *J. Chim. phys.*, **50**, 515–23 (*Oct.*, 1953) *In French.*

Two activator centres due to Cu in ZnS are pro-

posed, one giving blue emission due to Cu surrounded by S ions and one giving green emission due to the presence of one oxygen ion among the neighbouring ions. Attempts are made to explain the experimental characteristics of Cu-activated ZnS using these models. G. F. J. GARLICK

535.371

2307. Quenching of organic phosphorescence. M. KOIZUMI AND S. KATO. Letter in *J. chem. Phys.*, **21**, 2088–9 (*Nov.*, 1953).

By consideration of the various possible transitions between excited singlet state, triplet state and ground state of a molecule, formulae are derived for the fluorescence intensity and decay constant and the effect of quenching processes. It is concluded from theory and results for trypaflavine in filter paper that the triplet state is relatively unaffected in concentration quenching. G. F. J. GARLICK

535.371

2308. Mechanism of impurity poisoning in the luminescence of zinc sulfide phosphors with manganese activator. R. H. BUBE, S. LARACH AND R. E. SHRADER. *Phys. Rev.*, **92**, 1135–9 (*Dec.* 1, 1953).

An investigation was made of the poisoning effects of iron, cobalt, and nickel impurity in cub.-ZnS : Mn phosphors. The parameters varied included: (1) proportion of manganese, (2) proportion of poison impurity, (3) photon energy of the excited radiation, (4) intensity of the exciting radiation, and (5) operating temperature of the phosphor. Analysis of the results shows that the two most important poisoning mechanisms are: (1) dissipation by poison centres of energy absorbed by the host-crystal before this energy has been used to excite activator centres, a mechanism relatively independent of the proportion of manganese and type of poison, and (2) dissipative interaction between activator and poison centres, a mechanism which depends strongly on the proportion of manganese and type of poison. The first mechanism predominates when the primary excitation is absorbed by the host crystal, whereas the second predominates when the activator centres are excited directly. A.

535.371

2309. Variations in the decay of phosphorescence with frequency of applied electric field. K. W. OLSON. Letter in *Phys. Rev.*, **92**, 1323 (*Dec.* 1, 1953).

535.371

2310. Brightness waves and transitory phenomena in the quenching of luminescence by alternating electric fields. G. DESTRIAU. *J. appl. Phys.*, **25**, 67–72 (*Jan.*, 1954).

Zinc or cadmium sulphide phosphors, especially phosphors having short persistence, are less sensitive to ultraviolet light or to X-rays when they are submitted to the action of an alternating electric field. With a half-wave X-ray generator and an alternating field of frequency equal to the frequency of the potential applied to the X-ray generator (50 c/s), and in phase with it, the brightness waves are greatly modified. A sharp secondary maximum appears when the field passes through zero in each cycle; the amplitude of this maximum varies quickly during the cycles which immediately follow the application of the field. If the light is altered, the shape of the brightness wave varies according to the spectral region which is observed. A.

535.371

2311. Characteristics of radioluminescence in crystals. G. T. WRIGHT AND G. F. J. GARLICK. *Brit. J. appl. Phys.*, **5**, 13–18 (*Jan.*, 1954).

Measurements of scintillation light output *v.* α-particle energy were made for single crystals of organic and inorganic substances excited by monoenergetic α-particles. A new method is used to deduce a relation between the differential efficiency dL/dx and the specific energy loss dE/dx, which in the case of calcium fluoride was verified experimentally using thin evaporated layers. The effect of phosphorescent decay is observed by varying the circuit time constant. The intrinsic spread in scintillation pulse magnitude due to the phosphor was studied by inserting neutral filters between phosphor and photomultiplier and by variation in particle energy. Apart from a spread due to surface irregularities, sources of spread were observed in diamond probably due to alternation of fluorescent and non-fluorescent crystal domains, and in anthracene, most likely due to knock-on protons near the end of the α-particle track. A.

535.371 : 548.0

2312. On the photochemical sensitization of KBr crystals by addition of KH. W. MARTIENSSEN AND H. PICK. *Nachr. Akad. Wiss. Göttingen math.-phys. Kl.* IIa, *No.* 1, 117–19 (1952) *In German.*

535.371.07 : 621.396.963.325 : 621.385.832

2313. A device for simulating the visual displays of PPI scopes. J. L. BROWN AND A.L. DIAMOND. *J. Opt. Soc. Amer.*, **43**, 1143–6 (*Dec.*, 1953).

A circular transparency which duplicates the decay characteristic of a P-7 phosphor is carried by a rotating annulus. The density gradient of the transparency is such that the luminance of a given point on an illuminated screen in front of which it is rotated decreases with respect to time in the same manner as the luminance of a phosphor after excitation. The annulus is rotated at different speeds by a synchronous motor through a system of change gears and a friction drive. The spectral characteristic of the phosphor is duplicated as closely as possible by the use of an appropriate Wratten colour filter. Variations in over-all brightness of the presentation are obtained with polaroids and neutral density filters. A wide range of contrasts between the "target" and background is achieved by using a small piece of cellophane cut in the desired shape to represent the target. This is located between the polarizer and the analyser. Variations of luminance of the target and background are obtainable independently by appropriate changes in the relative orientations of the optical axis of the cellophane and the axes of polarization of polarizer and analyser. A.

535.372

2314. The luminescence spectrum of calcium tungstate according to the configuration coordinate model. H. F. HAMEKA AND C. C. VLAM. *Physica*, **19**, 943–9 (*Oct.*, 1953).

The configuration co-ordinate model has been used to calculate the luminescence band of $CaWO_4$ at

various temperatures. The force constant k_g of the harmonic vibration in the ground state has been computed from the vibrational Raman spectrum of WO_4^{2-}; the result is $k_g = 5{\cdot}8 \times 10^5$ dyn/cm. The force constant k_e for the excited state, deduced from the temperature dependence of the width at half the maximum intensity of the emission band, is $k_e = 1{\cdot}5 \times 10^5$ dyn/cm. In order to obtain satisfactory agreement between theory and experiment it is necessary to assume the variation in interatomic distance on excitation to be 0·20 Å which is in accordance with the analogous quantity of OsO_4 where a calculation from spectroscopical data yields an expansion of 0·15 Å. A.

535.372 : 535.343.2 : 548.7

2315. The ultraviolet absorption spectra and the intensity of the fluorescence band 4156 Å of diamond. B. M. Bishui. *Indian J. Phys.*, **26**, 347–56 (*July*, 1952).

The intensity of the fluorescence band 4156 Å of diamond with respect to that of the Raman line 1332 cm^{-1} excited by the Hg line 4358 Å was measured quantitatively in the case of eight specimens, using the method of heterochromatic photographic photometry. It has been observed that the transparency of the crystals for wavelengths shorter than 3000 Å cannot be correlated with the intensity of the fluorescence band. It is pointed out that these results do not support the conclusion arrived at by previous authors from visual observations that the intensity of the band increases with the increase of transparency of the crystal in the ultraviolet region. It is also observed that the intensity of the fluorescence band is large in the case of diamonds transparent only up to 2240 Å, when these show two absorption bands at 2360 Å and 2363·5 Å respectively and that the fluorescence band is much feebler in the case of crystals transparent up to 2240 Å and showing no absorption bands anywhere in the ultraviolet region. The intensity of the fluorescence band was not found to depend, however, on the amount of absorption in the absorption band at 4156 Å. It is concluded from these results that the fluorescence band 4156 Å is originated by some impurity which also produces the absorption bands at 2360 Å and 2363·5 Å, and that diamonds which may not possess this impurity in appreciable quantities, but possess some other impurities which produce absorption in the region 3000 Å, do not show the fluorescence band at 4156 Å with any appreciable intensity. It is further concluded that diamonds showing no absorption band anywhere in the spectrum up to 2240 Å are really diamonds of rare and the purest variety and only such diamonds should be classified under Type II, while the other diamonds showing absorption bands anywhere between 2240 Å and the red region should be classified under Type I. A.

535.375.5 : 535.89

2316. A light source for [the study of] Raman spectra. J. Barceló and M. T. Sardina. Note in *An. Real Soc. Españ. Fis. Quim.*, **48**(A), 117–18 (*March–April*, 1952) *In Spanish.*

The specimen is at the common focus of two ellipsoids each having a mercury lamp at the other focus. L. PINCHERLE

535.375.5 : 537.312.5

2317. The use of photomultipliers in Raman spectroscopy. H. J. Marrinan. *J. Opt. Soc. Amer.*, **43**, 1211–15 (*Dec.*, 1953).

The dark current and signal/noise characteristics of an RCA 1P21 and an E.M.I. VX5031 photomultiplier were compared from the point of view of their suitability for photoelectric Raman spectroscopy. The construction of a simple apparatus for the refrigeration of the RCA tube to liquid oxygen temperature is described. It is found that at low temperatures the noise associated with the dark current of the photomultiplier is negligible compared with the fluctuations (shot effect) in the photocurrent obtained when recording Raman spectra. Under these conditions the signal-to-noise ratio obtainable for a given rate of scanning of the spectrum depends solely on the square root of the light flux incident upon the photomultiplier, and cannot be improved by further refrigeration of the detector. A.

535.375.54

2318. The Raman spectra of 1,3-dibromopropane and 1,2,3-trichloropropane in the solid state. B. M. Bishui. *Indian J. Phys.*, **27**, 90–4 (*Feb.*, 1953).

These were investigated at −180°C. It was observed that in the first case some of the Raman lines disappear with solidification, while in the case of the second liquid all the prominent Raman lines persist even when the liquid is solidified and cooled to −180°C. It is pointed out that although the results reported by previous workers indicate the presence of two rotational isomers even in the case of normal paraffins in the liquid state and disappearance of one of the rotational isomers with the solidification of the liquids, the results observed in the case of 1,2,3-trichloropropane do not indicate such disappearance of one of the isomers with the solidification of the liquid. It is pointed out that the presence of extra lines cannot be due to presence of two isomeric molecules in the liquid state of this compound. A.

535.375.54

2319. Raman spectra of methyl methacrylate in the solid state at −180°C. N. K. Roy. *Indian J. Phys.*, **27**, 167–72 (*April*, 1953).

The Raman spectra of both monomeric methyl methacrylate in the solid state at −180°C and polymethyl methacrylate at −180°C were photographed and compared with those of the substances at room temperature. It is observed that in agreement with results of earlier workers the line 1640 cm^{-1} disappears and the line 1722 cm^{-1} becomes feebler when the monomer is polymerized to form plexiglass, and when the monomer is solidified and cooled to −180°C the intensity of line 1640 cm^{-1} diminishes to half its value observed in the case of the liquid, while the line 1722 cm^{-1} shifts to 1700 cm^{-1}, but its intensity remains unaltered. It is concluded that in the latter case the C=C bond of some of the molecules disappears to form regular bonds between neighbouring molecules, but as the C=O group remains intact the bonds do not form permanent chains and they break up with rise of temperature of the monomer. In the case of the polymer the fre-

quencies of some of the lines due to C—H and C—C valence oscillations diminish with lowering of temperature to −180°C. A.

535.375.54 : 539.132 : 548.736.4

2320. Raman spectra and structure of crystals of copper chloride and of double chlorides of copper and of alkali metals. J.-P. MATHIEU AND L. COUTURE-MATHIEU. *J. Chim. phys.*, **50**, 573–9 (*Oct.*, 1953) *In French.*

The frequency and symmetry type of the Raman lines observed for $CuCl_2$, $CuRb_2Cl_4$, CuK_2Cl_4, and $Cu(NH_4)_2Cl_4$ are tabulated. Interpretation of the spectra suggests the existence of the group $CuCl_2(H_2O)_2$ and the fundamental vibrations of this group and of the water molcules have been determined.

G. I. W. LLEWELYN

535.375.54 : 548.7

2321. The Raman effect in hydrated crystals. J.-P. MATHIEU. *J. Chim. phys.*, **50**, C 79–C 88 (*Sept.*, 1953) *In French.*

"Water molecules in solids," colloquium paper [see Abstr. 2866 (1954)]. Experimental results concerning the Raman spectrum of ice and of salt hydrates are discussed and the orientation of the water molecules in these crystals determined. The factors affecting the characteristic frequencies and the width of the Raman bands are considered.

G. I. W. LLEWELYN

535.375.54 : 548.7

2322. Studies on the Raman spectrum of the water of crystallization of gypsum. J. CABANNES, L. COUTURE AND J.-P. MATHIEU. *J. Chim. phys.*, **50**, C 89–C 90 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium [see Abstr. 2866 (1954)]. In the crystal of gypsum, the water molecules seem too perturbed to enable the observed Raman spectrum of the substance to provide any evidence either for or against the structure proposed by Wooster [*Zeitschrift für Kristallographie*, **94**, 375–96 (*Aug.*, 1936)]. G. I. W. LLEWELYN

535.375.54 : 548.7

2323. The bands of water in the monocrystals of hydrated magnesium sulphate and zinc sulphate $MgSO_4 . 7H_2O$ and $ZnSO_4 . 7H_2O$. R. LAFONT AND C. BOUHET. *J. Chim. phys.*, **50**, C 91–C 92 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. The Raman spectra of the hydrated salts are briefly interpreted.

G. I. W. LLEWELYN

535.375.54 : 548.7

2324. Analysis of orientation of water molecules in hydrated crystals using the Raman effect. J. CHAPELLE AND A. GALY. *J. Chim. phys.*, **50**, C 93–C 95 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. The classical theory of the orientation of water molecules in hydrated crystals leads to coherent results with $BaCl_2 . 2H_2O$. With $AlCl_3 . 6H_2O$, however, the observed spectrum does not permit a simple interpretation. G. I. W. LLEWELYN

535.375.54 : 548.7

2325. Interpretation of the Raman spectrum of the water molecules in seignette salt ($C_4H_4O_6NaK . 4H_2O$). J. CHAPELLE, G. CHAMPIER AND C. DELAIN. *J. Chim. phys.*, **50**, C 96–C 97 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. The experimental results permit a partial orientation of the water molecules. At temperatures below the Curie point (+28°c) the molecules are thought to form long chains in which the water molecules act as links. Above 28°c, the mobility of the water molecules increases to cause rupture of these chains, thereby destroying the ferroelectric state of the system. G. I. W. LLEWELYN

535.375.54 : 548.7

2326. The Raman spectrum of H_2O in $Li_2SO_4 . H_2O$. C. VASSAS-DUBUISSON. *J. Chim. phys.*, **50**, C 98–C 104 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. The observed Raman spectrum is figuratively represented. By correlation of results obtained from the Raman effect with previously recorded data from nuclear magnetic resonance studies, the orientation of the water molecules in the crystal is elucidated. G. I. W. LLEWELYN

535.376

2327. On the light yield of phosphors for excitation by electron beams of 5 to 60 kV acceleration potential. H. AREND AND H. IRMLER. Note in *Naturwissenschaften*, **40**, *No.* 22, 577–8 (1953) *In German.*

535.376

2328. On the light emission of carborundum crystals due to passage of current. M. SCHÖN. *Z. Naturforsch.*, **8a**, 442–6 (*July*, 1953) *In German.*

A theoretical study of electroluminescence in SiC crystals is given assuming a recombination process in three different cases, in *n*-type and in *p*-type regions and at *p-n* junction. The effect of the junction on the threshold field for emission and the resulting dependence of threshold field on temperature are considered. At large currents the effect of the *p-n* barrier is negligible and the emission then proportional to current. G. F. J. GARLICK

535.376 : 537.542

2329. Scintillations in CsI and γ-spectrometry. B. HAHN AND J. ROSSEL. *Helv. phys. Acta*, **26**, 7–8, 803–10 (1953) *In French.*

The study of γ-scintillations in cooled CsI crystal (without activator) gives the following results: (*a*) the pulse height at 100°K is nearly twice the one occurring in NaI(Tl) with the same optical geometry; furthermore the Po α-particles produce per MeV only 85% of the light effect of the γ's. Other differences between α- and γ-excitations are presented; (*b*) the crystal has a proportional response for γ-energy between 40 keV and 1·3 MeV; (*c*) as a measure of the resolution of a scintillation spectrometer with CsI crystal, the figure of 11% was obtained for the total width at half maximum of the photopeak of Ce^{141} γ-rays (145 keV). This small width as well as a comparison with α-scintillations indicate an absolute luminescence efficiency of about 40% for CsI. A.

535.378

2330. Triboluminescence of rubber. Z. CARRIÈRE. *Cahiers de Phys., No.* 46, 64–80 (*Nov.*, 1953) *In French.*

The light emission from adhesive tape unrolled in the dark is investigated in relation to tape constitution, speed of unrolling, etc. High electric fields occur at the line of separation but the light is stated to be triboluminescence and not a discharge. It is claimed that the experimental results imply the filamentary structure of rubber molecules. G. F. J. GARLICK

535.39

2331. Reflectance measurements from 1140 Å to 1190 Å by a simple open air method. J. D. PURCELL. *J. Opt. Soc. Amer.*, **43,** 1166–9 (*Dec.*, 1953).

A method for the rapid measurement of reflectance, transmittance and grating efficiencies in the region 1140 Å to 1190 Å is described. The method takes advantage of four narrow atmospheric transmission bands and requires no vacuum or dispersing system. The detector is an improved thermoluminescent phosphor which is sensitive only to wavelengths below 1340 Å. Reflectances obtained from samples of various materials are given, and ageing and cleaning of aluminium surfaces are studied. The measured efficiencies of four 15 000 lines/in. aluminium gratings ranged from ½ to 5%. A.

535.393 : 539.23

2332. The reflection of light from a metal coated with thin films. A. VAŠÍČEK. *Czechoslovak J. Phys.*, **1,** *No.* 2, 73–7 (1952).

The formulae deduced for the reflection of light from glass covered with multiple thin films may be generalized for the reflection of light from a metallic mirror with many thin films. Thin films on the metal change (decrease or increase) the reflectance of the metallic mirror and protect it against corrosion. A.

535.41 : 530.162

2333. An optical uncertainty principle and its application to the amount of information obtainable from multiple-beam interferences. E. INGELSTAM. *Ark. Fys.*, **7,** *Paper* 24, 309–22 (1953).

An uncertainty principle is applied to the consideration of the limit of accuracy obtainable from multiple-beam interferograms. The influence of diffraction on fringe image formation is discussed in detail. It is shown how great sensitivity in depth necessarily leads to reduced information in extension. This follows from uncertainty considerations which lead to a relation between the height uncertainty Δz, the uncertainty in extension Δx, the order N and the wavelength λ such that $\Delta x \,.\, \Delta z \sim N\lambda^2$. The discussion is extended from the viewpoint of information theory, which leads to similar results. S. TOLANSKY

535.41 : 778.3

2334. Use of high contrast in the photography of interference fringes. J. M. HOUGH AND B. J. GOLDSMITH. Letter in *Nature* [*London*] **172,** 1105–6 (*Dec.* 12, 1953).

High-contrast photography makes it possible to render an interference pattern as black and white without any intermediate greys and variation of the exposure makes it possible to change the intensity at which the pattern changes from black to white.

J. M. HOUGH

535.417 : 535.33.07

2335. Investigation into the best conditions for using a Fabry–Perot photoelectric spectrometer. R. CHABBAL. *J. Rech. Cent. Nat. Rech. Sci.*, **5,** 138–86 (*Sept.*, 1953) *In French.*

A very complete analytical theoretical examination of the Fabry–Perot interferometer. The effects of curvature on the plates and the effects of polish errors are discussed. Calculations are made for an ideal instrument for resolution and transmission. The effect of source line-width is discussed. Curves for resolving power are derived. Contrast is discussed. The variation of transparency with sharpness is discussed for a variety of multilayer reflectors. Calculations are made both for absorbing and non-absorbing films. Numerical examples are worked out for each case derived. A table is drawn up indicating the luminosity conditions with different parameters. S. TOLANSKY

535.417 : 539.23

2336. The use of multilayer high reflecting films for reflection multiple-beam interferometry. S. TOLANSKY. *Vacuum*, **2,** 231–44 (*July*, 1952—publ. *Sept.* 1953).

Multilayers of alternate high and low refractive index quarter-wave films can be produced to give reflecting coefficients ranging from 0·31 to 0·97. These have very low absorptions and have been adapted to use for multiple beam interferometry, especially for reflection fringes. The advantages are enumerated and discussed. The experimental production of the multilayers is reviewed. Applications to interferometry are illustrated with various examples employing low and high reflectivities. Lines of investigation for securing future improvements are indicated. A.

535.417–15

2337. Concerning the use of the Fabry–Perot interferometer for wave-number measurement in the infrared. J. H. JAFFE. *J. Opt. Soc. Amer.*, **43,** 1170–3 (*Dec.*, 1953).

Many workers have used channelled spectra produced by a Fabry–Perot interferometer to calibrate infrared spectrometers. In this paper the effects of the finite height of the spectrometer slit and the finite aperture of the condensing lens on the visibility of the spectra are discussed. The way in which maximum accuracy of calibration is to be obtained for any given experimental arrangement is indicated. A.

535.42 : 535.822

2338. Formation of images in the microscope. P. LACOMME. *Nuovo Cimento*, **9,** *Suppl. No.* 3, 333–5 (1952) *In French.*

The problem of the diffraction pattern of a small hole in an opaque screen is treated algebraically and numerically for natural and polarized light for an objective of aperture 0·95. D. H. WHIFFEN

535.42 : 537.533.73

Analogy between diffraction of light and electrons. *See Abstr.* 2490–1

535.43 : 535.242

2339. Visual diffusiometer. L. PROD'HOMME. *Rev. Opt.*, **32,** 615–18 (*Nov.*, 1953) *In French.*

Description of a visual photometer specially designed for accurate measurement of the scattering

constant of optical glasses. The instrument has a beam separator, a photometric wedge and a Lummer cube. It is used with monochromatic light. The accuracy may be 1/100 on a brightness range from 1 to 10 000. A.

535.435 : 532.7

2340. Temperature dependence of anisotropy of some *ortho-* and *para*-disubstituted benzenes. M. MAZUMDER. *Indian J. Phys.*, **27**, 129–36 (*March*, 1953).

The factor of depolarization of the Rayleigh scattering in CCl_4, *o*-chlorotoluene, *p*-chlorotoluene, *o*-cresol and *p*-cresol at different temperatures due to the mercury lines 4047 Å and 5461 Å as the incident light was determined by spectrophotometry in order to find out whether the anisotropy changes with temperature in the same way in the case of both ortho- and para-compounds. By using Soller slits the corrected value of ρ in the case of carbon tetrachloride was found to be 0·054 at 34°C which changed to 0·039 at 65°C. The value of δ was found to remain almost constant within this range of temperature. In the case *p*-chlorotoluene and *p*-cresol the values of δ calculated from the observed values of ρ and β for different temperatures showed that δ remains constant up to a temperature just below the boiling points of the liquids, while in the case of the ortho-compounds it was found from similar data that δ increased by about 50% with the rise of temperature mentioned above. It is concluded that in the case of the ortho-compounds, breaking up of associated groups of molecules is responsible for the increase in δ with temperature. A.

535.5 : 548.7

2341. The form birefringence of macromolecules. W. L. BRAGG AND A. B. PIPPARD. *Acta cryst.*, **6**, 865–7 (*Nov.*, 1953).

Perutz [Abstr. 2919 (1954)] has shown that the birefringence changes when the water in a haemoglobin crystal is replaced by salt solution. The effect of this substitution in the birefringence is calculated and compared with Perutz's observations. There is agreement as to the order of magnitude of the effect, but the optical data indicated a more elongated molecule ($a/b \sim 1{\cdot}45$) than that deduced from the X-ray data ($a/b \sim 1{\cdot}3$). This discrepancy is not to be stressed, since the form of the molecule is not yet certain and the measurements of change in birefringence are very approximate. A further exploration of the effect may yield a useful method of estimating the form of other protein molecules. A.

535.514.2

2342. The influence of the internal stress in dielectrics on the polarization of reflected light. Z. GALASIEWICZ. *Acta phys. Polon.*, **11**, *No.* 2, 91–8 (1952).

The refractive index considered as a function of the strains has been introduced into the equations describing the state of polarization of light reflected from a strained dielectric. Glass has been chosen as example since the Neumann constants are known from experiment for this material only. The relation between the rotation of the plane of polarization of reflected (plane polarized) light and uniform pressure normal to the plane of incidence has been deduced, as well as a relation between the rotation of the plane of polarization of reflected light and the state of plane stress within the dielectric. The latter relation yields one equation for the determination of the two principal stresses. The second equation needed can be deduced from the fundamental equation of photoelasticity connecting the phase shift of transmitted light with the stress within the dielectric. A.

535.55

2343. Photo-elastic behaviour of barium nitrate and lead nitrate crystals. S. BHAGAVANTAM AND K. V. KRISHNA RAO. *Acta cryst.*, **6**, 799–801 (*Oct.*, 1953).

All the constants needed to describe the photo-elastic behaviour of barium and lead nitrate crystals, which belong to the T_h class, were determined using sodium *D* light. It is found that these crystals exhibit several exceptional features in regard to this property. A.

535.64

2344. Evaluation of a specified illuminant in comparison with a standard illuminant by means of a new definition of [illuminant] difference. H.-W. BODMANN. *Ann. Phys.* [*Leipzig*] **12**, *No.* 7–8, 348–60 (1953) *In German.*

From the spectral energy distribution curve of a light the value of the function $b(\lambda) = V(\lambda) \cdot I(\lambda)$ is found, where $V(\lambda)$ and $I(\lambda)$ are respectively the relative luminous efficiency and the energy, both at wavelength λ. The function

$$F^2 = \{\int b(\lambda) \cdot B(\lambda)d\lambda\}^2 / \int b^2(\lambda)d\lambda \cdot \int B^2(\lambda)d\lambda$$

is then found by graphical integration, $b(\lambda)$ referring to the specified illuminant and $B(\lambda)$ to the standard. The expression for the difference between the illuminants is d where $d^2 = 1 - F$. Using daylight as the standard, the values of d are, for sunlight 0·06, for tungsten light 0·2 and for a "daylight" fluorescent lamp 0·4. The theory underlying the expression adopted for d is discussed. J. W. T. WALSH

535.65

2345. Application of a color-difference index to highly selective transparent specimens. A. C. WEBBER AND F. W. BILLMEYER, JR. *J. Opt. Soc. Amer.*, **43**, 1127–36 (*Dec.*, 1953).

The Adams colour difference index has been applied to small colour differences (mainly obtained from exposure to light) between highly selective transparent colours in acrylic resins. The results have been compared with visual estimates of the colour differences. A satisfactory correlation, with some interesting exceptions, exists between the two methods. A.

535.65

2346. Comparison of colorimetric results from a normal-diffuse spectrophotometer with those from a 45-degree-normal colorimeter for semi-glossy specimens. W. E. K. MIDDLETON. *J. Opt. Soc. Amer.*, **43**, 1141–3 (*Dec.*, 1953).

While the illuminating and viewing conditions in the Hardy/General Electric recording spectrophotometer seem to have advantages in the measurement of textiles, they do not give results in accord with ordinary experience in the measurement of some other kinds of sample, particularly glossy and semi-glossy paints. This assertion is documented further by an analysis of recent British measurements on paint samples. A.

535.7 : 612.84

Physiological optics. *See Abstr.* 2972–81

535.81–15

2347. New optical glasses with good transparency in the infrared. R. Frerichs. *J. Opt. Soc. Amer.*, **43**, 1153–7 (*Dec.*, 1953).

Optical glasses were produced using arsenic trisulphide as a network former and different sulphides as network modifiers. These glasses transmit infrared up to 12–13 μ in thicknesses useful for optical purposes. The transmission of glassy selenium was determined up to 21 μ and a few composite selenium glasses were investigated. A.

535.822 : 535.42

Formation of images in the microscope. *See Abstr.* 2338

535.822.9

2348. The contrast effect of lens-like objects in phase microscopes. A. Frey-Wyssling. *Naturwissenschaften*, **40**, *No.* 20, 517–20 (1953) *In German.*

Lens-like objects yield, in the phase contrast microscope, a peculiar mixture of bright-field and phase-contrast images. Owing to the power of the object, the image of the diaphragm no longer falls on the exit pupil of the objective and the light passing through the edges of the object by-passes the phase plate and forms a bright-field image. The light from the central portion of the object is still seen in phase contrast, either positive or negative according to the relative refractive indices of object and medium. The effect also is shown to depend upon the curvature of the object. R. W. FISH

535.822.9

2349. The Mirau interference microscope for the measurement of surface finish. G. Delauney. *Rev. Opt.*, **32**, 610–14 (*Nov.*, 1953) *In French.*

A simple interference microscope is described, suitable for use in a workshop to measure the surface finish of small metal parts. Many practical details are given. R. W. FISH

535.834

2350. Experimental study of curvature of field. J. Montojo y Belda. *An. Real Soc. Españ. Fis. Quim.*, **49**(A) 31–6 (*Jan.–Feb.*, 1953) *In Spanish.*

The shape and position of the image observed by the eye with binoculars of different types were experimentally studied. By comparing such a shape and position with those of the sagittal and meridional images, useful conclusions are deduced for the correction of field curvature. A.

HEAT 536

536.2

2351. On a problem in the theory of heat and its solution by means of Fourier and Laplace transformations. H. Delavault. *C.R. Acad. Sci.* [*Paris*] **237**, 1067–8 (*Nov.* 2, 1953) *In French.*

Discusses the cooling of a solid confined between two parallel planes. F. E. HOARE

536.2.083

2352. Thermal diffusivity of metals at high temperatures. P. H. Sidles and G. C. Danielson. *J. appl. Phys.*, **25**, 58–67 (*Jan.*, 1954).

A modified Ångström method for measuring thermal diffusivity and hence thermal conductivity of metals has been developed. Like previously reported dynamic methods, this method uses a heat source whose temperature varies sinusoidally with time located at one end of an effectively infinite rod. Unlike these methods only one period of the heat pulse is required to eliminate the unknown coefficient determining the heat lost by radiation since both velocity and amplitude decrement of the heat pulse are measured. In addition to providing greater reliability at high temperatures by using only one period, the new method is faster in taking data and simpler in computation. The thermoelectric potentials from two thermojunctions are amplified and plotted on a Brown Electronic recorder in order to obtain a permanent record of all necessary data for computing the thermal diffusivity. Results for copper, nickel and thorium over the temperature range 0–500°c are given. A.

536.21 : 54

2353. Heat capacity and thermal diffusivity of silver bromide. T. E. Pochapsky. *J. chem. Phys.*, **21**, 1539–40 (*Sept.*, 1953).

Rapid heat capacity measurements are reported for silver bromide at temperatures in the range from room temperature to 411°c. Thermal diffusivities and conductivities are derived for the same temperature range from an analysis of the cooling of a platinum wire embedded in the bromide. The results show that vacancy equilibrium is established in less than about 10^{-4} sec above 350°c. A.

536.21 : 54

2354. Thermal conductivities of single- and polycrystalline bismuth. S. Nishioka. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 147–54 (*Dec.*, 1949).

Thermal conductivities of single- and polycrystalline bismuth were measured by using specimens in the form of a cube. The values found at 14°c were as follows: the thermal conductivity of polycrystal 0·01914 cal./cm.sec.deg; the thermal conductivity of single crystal parallel to the trigonal axis, 0·012 cal/cm. sec. deg; the thermal conductivity of single crystal perpendicular to the trigonal axis, 0·022 cal/cm. sec. deg. Linder's theory for the relation between the thermal conductivities of single- and polycrystalline bismuth was verified by applying the above values. Measurements were also carried out on several specimens in the form of rectangular plates of single crystal, of which the orientation of the trigonal axis with respect to the normal to the plate ranged from 0° to 89°. The results showed that the Voigt-Thomson's relation is satisfied fully for thermal conductivities of bismuth.

536.212.2 : 536

2355. Thermal conductivity of copper between 0·25°K and 4·2°K. J. Nicol and T. P. Tsien. Letter in *Phys. Rev.*, **92**, 1062 (*Nov.* 15, 1953).

Measurements at temperatures lower than 1° were made with two cylinders of chromium alum which were cooled magnetically to different temperatures and connected with a copper wire; thermal con-

ductivity was derived from the rate at which the temperatures of the cylinders equalized. Measurements at temperatures higher than 1° were made with standard, steady state, methods. Corrections were made for heat flow from external sources and for the thermal resistance of the contact salt–copper (proportional to T^{-2}). The thermal conductivity is found to be proportional to the absolute temperature in the whole range of observation. R. EISENSCHITZ

536.22

2356. Thermal conductivity of heavy water. F. MEYER AND M. EIGEN. Note in *Z. Naturforsch.*, **8a**, 500–1 (*Aug.*, 1953) *In German.*

Measurements are carried out on a column of liquid (within a guard ring) under conditions of steady heat flow in vertical direction. An accuracy of 1% is claimed. Plotting the thermal conductivity of D_2O against the temperature gives an almost linear graph between 10 and 60°C. The corresponding graph of H_2O is almost parallel; thermal conductivity of D_2O is by 3% smaller than that of H_2O. Results are interpreted in terms of transfer of translational and rotational energy and of energy of "dissociation." It is claimed that previous theoretical considerations are borne out by the present experiments. R. EISENSCHITZ

536.23 : 536.25

2357. Ratio of convection to conduction loss from a hot wire stretched along the axis of a vertical cylindrical tube. E. D. TAYLOR, B. BERGER AND B. E. WESTERN; J. A. V. FAIRBROTHER. Letter in *Brit. J. appl. Phys.*, **4**, 382 (*Dec.*, 1953).

It is suggested that in a recent paper Fairbrother [Abstr. 6702 (1953)] did not give a general treatment of the problem and that the assumption of no vertical temperature gradient was erroneous. In reply it is stated that the flow was laminar and that the assumptions were valid for the particular experimental [illegible] gement used. E. H. DOCK

536.24

2358. The effect of fluid motion on heat transmission. I. Vertical cylinders. D. G. KAPADNIS. *Indian J. Phys.*, **27**, 77–89 (*Feb.*, 1953).

The effect of an air stream on convective heat transfer rate was studied under different ambient conditions and the experimental data are compared with those of previous workers. The experimental results show that (1) The heat transmission does not increase quite so fast as the air velocity—the rate of heat transfer being proportional to 0·517th power of air velocity; (2) As the characteristic dimension of the vessel is reduced its convective heat transfer per unit area per unit temperature excess increases; (3) For an air stream striking the cylinder at an angle of 45° the heat transfer rate is about three-quarters, and for flow parallel to the axis about one-half that for flow at right angles to the axis; there is a small variation in heat dissipation for inclinations above 60°; (4) Clothing affects the heat transfer rate but the efficiency of insulation deteriorates with the increase in air velocity; the double layer of clothing increases the protection effect of the garments is negligible in comparison with the effect of wind penetration. A.

536.253

2359. The temperature decay law of a naturally convected air stream. W. RAILSTON. *Proc. Phys. Soc.* [*London*] *B*, **67**, 42–51 (*Jan.*, 1954).

Temperature measurements were made both vertically and transversely in the plume of air rising by natural convection from an electrically heated gauze in a still atmosphere. Schlieren methods made the air stream visible, so that the type of air flow could be observed at different levels. The results are in good agreement with the dynamical theory of naturally convected gases developed by O. G. Sutton [*J. Meteorol.*, **7**, 307 (1950)]. A.

536.33 : 537.311.1

On the theory of electrical fluctuations and thermal radiation. *See Abstr.* 2417

536.413

2360. Thermal contraction of a split hollow cylinder. W. KARUSH AND A. V. MARTIN. *J. appl. Phys.*, **24**, 1427–31 (*Dec.*, 1953).

Consider a long hollow cylinder which is radially split along its entire length. When such a cylinder is heated, its inner radius undergoes a change δa. The cylinder is called stable if $\delta a \leqslant 0$. An approximate solution for δa is derived and is used to determine conditions for stability. The pressure against the inner surface required to prevent the contraction δa is also derived. A.

536.413 : 548.0

2361. Isotope effect and thermal expansion coefficients of crystals. C. E. NORDMAN AND W. N. LIPSCOMB. Letter in *J. chem. Phys.*, **21**, 2077 (*Nov.*, 1953).

Gives an outline of a quantitative discussion of the thermal expansion coefficients of LiH, LiD and LiT. Numerical values are given for all three. C. TURNER

536.423

2362. Effect of surface films on the evaporation of water. W. W. MANSFIELD. Letter in *Nature* [*London*] **172**, 1101 (*Dec.* 12, 1953).

Monolayers significantly reduce the rate of evaporation of water in laboratory experiments, but, in general, not in natural conditions in the Melbourne summer. This is attributed to diminution of surface cooling accompanying diminution of evaporation itself. However, in absence of much solar radiation or in the presence of strong wind, surface films diminish evaporation. L. G. CARPENTER

536.423.1

2363. The use of carbon crucibles in measurements on the rate of evaporation of liquid metals in a vacuum. M. G. ROSSMANN AND J. YARWOOD. *Brit. J. appl. Phys.*, **5**, 7–13 (*Jan.*, 1954).

The conditions are discussed which need to be fulfilled to obtain measurements on the evaporation of metals which liquefy when at elevated temperatures in a vacuum. A new type of crucible for such work is described. The impedance of a crucible to flow of metal vapour is considered theoretically. Experimental results for the evaporation rates of mercury, silver and gold are given. A.

536.423.1 : 532.528 : 532.7

2364. Theory of the formation of bubbles. S. TAKAGI. *J. appl. Phys.*, **24**, 1453–62 (*Dec.*, 1953).

The perfect theory of the formation of bubbles in the case where the bubbles of vapour are nucleated

spontaneously in pure liquid is presented. This is done by the systematization of the classical theory of M. Volmer (*Kinetik der Phasenbildung*, 1939) and the theory of D. Turnbull and J. C. Fisher [*J. chem. Phys.*, **17**, 71 (1949)] and it coincides satisfactorily with the experiment of K. L. Wismer [*J. phys. Chem.* **26**, 301 (1922)]. Theory must be advanced further so as to afford a perfect explanation of the processes of boiling, cavitation and the critical phenomena of the movement of soil moisture. To effect this object, the author has calculated the rate of formation of bubbles at a surface. The theoretical value, however, of the negative pressure at which the liquid fractures does not coincide by any means with the atmospheric pressure in the process of boiling. This is true also in the process of cavitation and in the process of critical phenomena of the movement of soil moisture. Some other factors must be introduced in order to bring the theory to a state of practical value. A.

536.44

2365. Gravitational effects in *PVT* measurements in the critical region. W. G. Schneider and H. W. Habgood. Letter in *J. chem. Phys.*, **21**, 2080–2 (*Nov.*, 1953).

The critical isotherm of xenon has been investigated using a bomb 25 cm by 10 mm mounted vertically with an arrangement for measuring the pressure at any desired height in the bomb. The shape of the isotherm is found to depend markedly upon yhe position at which the pressure measurements are made. Measurements previously made with the same bomb horizontally mounted are used to calculate the shape of the curves expected in a vertical bomb. Good agreement is shown with the experimental results. The method of obtaining the true isotherm in the absence of gravitational effects is discussed briefly. F. E. HOARE

536.46 : 537.521.7

2366. The production and measurement of surge-ignition sparks. J. K. Richmond and A. L. Furno. *Rev. sci. Instrum.*, **24**, 1107–12 (*Dec.*, 1953).

In order to be able to study effectively the flammability characteristics of mixtures of hydrocarbon vapours and air, a surge generator, oscillograph, and associated equipment have been designed to deliver suitable ignition sparks and to study their characteristics. The duration, energy content, and wave shape of these sparks have been measured and studied to determine the effect that these spark parameters might have on the ignition process. A.

536.48

2367. Adsorption of helium on glass at temperatures below the λ-temperature. H. H. Tjerkstra, F. J. Hooftman and C. J. N. van den Meydenberg. *Physica*, **19**, 935–42 (*Oct.*, 1953).

A new differential gauge, giving an accuracy of $0{\cdot}1\,\mu$ at a total pressure of a few mm of Hg, is described. Kistemaker's provisional conclusion that below the saturated vapour pressure several layers of helium are adsorbed has not been confirmed. A.

536.48

2368. Optical determination of the thickness of the unsaturated helium II film. N. G. McCrum and K. Mendelssohn. Letter in *Phil. Mag.*, **45**, 102–4 (*Jan.*, 1954).

The thickness of the helium film was determined by optical measurements at 2·15, 2·10, 1·87 and 1·84°K and at pressures between 60 and 100% saturation. Particular care was taken for ensuring constancy of temperature. Reproducible results are obtained. Thickness plotted against pressure is shown to be a smooth curve. It is found that the thickness increases rapidly between 95 and 100% saturation. R. EISENSCHITZ

536.48

2369. Liquid helium II: Bose–Einstein condensation and two-fluid model. P. R. Zilsel. *Phys. Rev.*, **92**, 1106–12 (*Dec.* 1, 1953).

The Bose–Einstein condensation mechanism is shown to be capable of accounting for the existence of separate hydrodynamic velocity fields for the normal and the superfluid, provided suitable assumptions are made with regard to the single-particle energy spectrum. The effect on the microcanonical gas distribution of imposing a non-zero value of the total momentum **P** is considered. For an ordinary gas the effect is trivial, the whole distribution being merely shifted in momentum space. However, in the case of a degenerate Bose gas whose single-particle energy spectrum has a sharp minimum (gap or cusp), only the excited part of the gas (normal fluid) participates in the imposed motion, the condensate (superfluid) remaining "frozen" in momentum space. This rigidity of the condensate in momentum space plays the same rôle as the rigidity of the superelectrons on imposition of a magnetic field in the London theory of superconductivity. **P** acts as an additional thermodynamic variable, states with $\mathbf{P} \neq 0$ being macroscopically metastable and corresponding to the existence of a relative velocity between normal and superfluid. The basic hydrodynamic assumption of the two-fluid model is thus reduced to an assumption concerning the form of an effective single-particle energy spectrum, and the parallelism between the theories of superconductivity and superfluidity is clearly exhibited. The present theory permits, in particular, the introduction of the mathematical form of Landau's phonon and "roton" spectra within the framework of the Bose–Einstein condensation picture. The statistical-thermodynamic formulae are derived and are shown to lead to characteristic two-fluid equations derived previously from a variational principle. A.

536.48

2370. The propagation of heat in liquid helium. J. M. Ziman. Letter in *Phil. Mag.*, **45**, 100–2 (*Jan.*, 1954).

The author applies the familiar differential equation of thermal conduction in one dimension to the propagation of a square heat pulse and calculates the shape of the pulse at the receiving end. The result is in fair agreement with an observed heat pulse propagated through liquid helium. Application of the ordinary theory of thermal conduction is justified by assuming that heat is transported by phonons undergoing random reflections at the walls of the tube, provided that the tube is long and thin. The

diffusivity is found to be proportional to the radius of the tube and the velocity of the phonons.

R. EISENSCHITZ

536.483

2371. Results of investigations at low temperature. XI. A plant for the liquefaction of technical-grade hydrogen. K. CLUSIUS. *Z. Naturforsch.*, **8a**, 479–93 (*Aug.*, 1953) *In German.*

For Pt X, see Abstr. 6014 (1953). In this liquefier, which has an output of 7 l/hour, the crude hydrogen is purified by cooling it to 30°K at nearly atmospheric pressure. This has the advantage that in a low pressure circuit it is easier to allot sufficient space for the deposition of solid impurities, so that technical-grade gas can be used. Furthermore, a more complete purification is obtained by cooling at low pressures, because owing to the van der Waals attraction the concentration of impurities in equilibrium with the solid in dense cold hydrogen is considerably higher than at low pressure. Thus there is no need for employing charcoal absorption, which is frequently used in conventional liquefiers. The purified gas joins the returning expanded hydrogen at 65°K and is from then onward part of an ordinary liquefaction circuit, needing no further treatment but an oil trap and KOH-dryer. At an operating pressure of 160 atm. and with precooling to 65°K with liquid nitrogen a liquefaction rate of 24·4% is obtained. This is 94% of the theoretical thermodynamic efficiency.

H. LONDON

536.483 : 538.07

2372. Liquid helium cooled coils for making intense transient magnetic fields. J. L. OLSEN. *Helv. phys. Acta*, **26**, *No.* 7–8, 798–802 (1953).

The very economical production of transient magnetic fields above 10^5 Oe with coils immersed in liquid helium is discussed. Graphs are given to facilitate calculation of coil heating. A.

536.5.081

2373. The preparation and use of cells for the realization of the triple point of water. C. R. BARBER, R. HANDLEY AND E. F. G. HERINGTON. *Brit. J. appl. Phys.*, **5**, 41–4 (*Jan.*, 1954).

The Ninth General Conference of Weights and Measures which met in October 1948 passed a resolution that the zero of the International Temperature Scale should be defined as being the temperature 0·0100 deg c below that of the triple point of water. The technique used for preparing cells is described and the results obtained by the use of these cells over an extended period are discussed. A.

536.511

2374. A meniscus thermometer for the measurement of small temperature differentials. S. J. BORGARS. Letter in *J. sci. Instrum.*, **30**, 487 (*Dec.*, 1953).

In order to measure accurately the maximum periodic change of temperature within a closely controlled test chamber a type of "constant" pressure air thermometer was used. A thin-walled glass bulb is blown at the end of a capillary tube and the latter is bent so that part of it is horizontal. A very short column of low vapour pressure silicone oil is situated in the horizontal tube and moves as the air in the bulb expands or contracts with changing temperature. Allowance for changes in the atmospheric pressure is made by having an exactly similar tube with the bulb in melting ice. Sensitivity obtained was 24·8 cm/°c at 18°c and 31 cm/°c at −40°c and a temperature differential could be measured to ±0·004°. E. H. DOCK

536.521

2375. A new photoelectric pyrometer. A. PEUTEMAN. *C.R. Acad. Sci.* [*Paris*] **237**, 975–7 (*Oct.* 28, 1953) *In French.*

The vacuum cell has a disk cathode of caesium on silver oxide, and the anode cylinder is maintained at 4 V. The incident radiation is limited by two diaphragms and two filters to a region about 680 mμ. Modulation is produced by a "holed" disk and the output is suitably amplified. The sensitivity is about one mV per 5 deg at 1600°c and the instrument can be used in the range 1300–2000°c. E. H. DOCK

536.53 : 621.362 : 621.383 : 621.317.321

2376. A phototube measuring circuit for thermopiles. R. K. BRINTON AND C. T. O'KONSKI. *Rev. sci. Instrum.*, **24**, 1102–4 (*Dec.*, 1953).

A recording system is described which measures the electromotive force generated by slowly responding linear-type thermopiles. A means is provided for compensating electrically for the zero signal drift so that the thermopile may be used conveniently under rather unstable thermal surroundings. A twin phototube arranged in a feedback type amplification circuit is used as a receiver for the light beam reflected from the mirror of a sensitive galvanometer connected in series with the thermopile. The current from the feedback circuit which automatically keeps the galvanometer essentially at its zero signal position is directly proportional to the thermopile signal. This current may be measured by a conventional microammeter or an automatically recording meter if desired. A.

536.531

2377. A zinc oxide resistance thermometer. L. WEIL, J. PERETTI AND A. LACAZE. *C.R. Acad. Sci.* [*Paris*] **237**, 974–5 (*Oct.* 28, 1953) *In French.*

A layer of Zn is applied to a ceramic base by a vacuum technique and converted to the oxide by heating at 400–450°c in air or oxygen. Leads of silver are applied under vacuum. Stability is said to be better than that of colloidal graphite and the accuracy 0·01 against 0·1 deg for graphite. In the region of 2°K the resistance varies by about 10% per degree. E. H. DOCK

536.532 : 533.6.08

Response of two-material laminated cylinder to simple harmonic environment temperature change. *See Abstr.* 2102

536.581.1

2378. A new method of improving furnace temperature control. W. JAMES. *J. sci. Instrum.*, **31**, 23–5 (*Jan.*, 1954).

A modified bridge circuit, using an indirectly-heated thermistor, is described which may be used either to reduce the temperature differential of a resistance-thermometer, on-off type temperature controller, or to convert such a controller for time-cycle proportional operation. The instrument has been

used to control the temperature of a laboratory furnace to better than $\pm\frac{1}{4}$ deg for periods of several hours. A.

536.62 : 536.63

2379. On the direct calorimetry of insulators, and particularly of liquids. P. VERNOTTE. *C.R. Acad. Sci.* [*Paris*] **237,** 1218–20 (*Nov.* 16, 1953) *In French.*

Outlines and gives the theory of a method by which the specific heat of liquids may be determined. The principle is to supply heat at a steady rate to an isolated (no thermal loss) layer of liquid and measure the rate of rise of temperature at a given point. It is shown that the quotient of the rates of heat supply and of temperature rise, the temperature throughout the liquid not being uniform, gives the specific heat at the mean temperature of the liquid. No results given. F. E. HOARE

536.631 : 536.48

2380. The specific heat of $MnCl_2 . 4H_2O$ between 1°K and 22°K. S. A. FRIEDBERG AND J. D. WASSCHER. *Physica,* **19,** 1072–8 (*Nov.*, 1953).

A λ-shaped anomaly in the C_p *v.* T curve is found having its maximum at 1·62°K. The anomaly is probably of magnetic origin, 1·62°K being the critical temperature at which the salt transforms from the antiferromagnetic to the paramagnetic state. The entropy change associated with the complete process is found to be 1·75 R/mol deg. A.

THERMODYNAMICS 536.7/.8

536.7

2381. On the principle of least dissipation of energy. H. WERGELAND. *K. Norske. Vidensk. Selsk. Forhandl.*, **24,** *No.* 25, 110–13 (1951).

Onsager's variational principle obtained by specifying constancy of temperature and prescribing the normal fluxes is examined. It is shown that the stationary state may be equally well characterized by a minimum of dissipation when the temperature and chemical potentials are prescribed on the surface of the system. F. E. HOARE

536.7

2382. On Onsager's relations in a magnetic field. P. MAZUR AND S. R. DE GROOT. *Physica,* **19,** 961–70 (*Oct.*, 1953).

Onsager's theory is extended to the case of systems with a magnetic field, which is a continuous function of space. The reciprocal relations between phenomenological coefficients are found to be $L_{ji}(\mathbf{r}', \mathbf{B}'; \mathbf{r}, \mathbf{B}) = L_{ij}(\mathbf{r} - \mathbf{B}; \mathbf{r}' - \mathbf{B}')$, where i and j number state variables of various kinds (which are continuous functions of space and time), $\mathbf{r}'$ and $\mathbf{r}$ indicate space co-ordinates of two positions in the system, $\mathbf{B}'$ and $\mathbf{B}$ denote the magnetic fields at those positions. The implications of these reciprocal relations on the symmetry properties of the electric and heat conduction tensors are derived. For this purpose it was necessary to define insulation for systems, in which electromagnetic phenomena occur, from appropriate thermodynamic considerations. A.

536.7

2383. Relativistic thermodynamics of irreversible processes. II. Heat conduction and diffusion; physical part. G. A. KLUITENBERG, S. R. DE GROOT AND P. MAZUR. *Physica,* **19,** 1079–94 (*Nov.*, 1953).

For Pt I, see Abstr. 1269 (1954). The results of the relativistic thermodynamics of irreversible processes in an isotropic mixture of an arbitrary number of chemical components are reformulated, so far as heat conduction and diffusion are concerned, in three-dimensional tensor form with the help of quantities which are used in the non-relativistic theory. The transformation properties of the vectors $\mathbf{J}^{(j)} = \rho^{(j)}(\mathbf{v}^{(j)} - \mathbf{v})$, where $\rho^{(j)}$ = density of rest mass of component j, $\mathbf{v}^{(j)}$ = velocity of component j, $\mathbf{v}$ = barycentric velocity, are examined. It is seen that $\mathbf{J}^{(j)} = \mathbf{J}'^{(j)}_{\perp} + \mathbf{J}'^{(j)}_{||}(1 - \mathbf{v}^2/c^2)^{\frac{1}{2}}$, where $\mathbf{J}'^{(j)}$ is the vector $\mathbf{J}^{(j)}$ measured by an observer in the Lorentz frame where $\mathbf{v} = 0$ and $\mathbf{J}'^{(j)}_{\perp}$ and $\mathbf{J}'^{(j)}_{||}$ are the components of $\mathbf{J}'^{(j)}$ perpendicular and parallel to $\mathbf{v}$ respectively. As a consequence of the developed formalism it appears that the density of entropy, multiplied by a constant, is the fourth component of a four-vector. It is seen that in the absence of heat conduction and diffusion the entropy in a small element of volume is a Lorentz invariant quantity. Further, it appears that in all practical cases if there is heat conduction and diffusion the change of the entropy in an element of volume is only very small under Lorentz transformations. The connection between different sets of heats of transfer occurring in the literature is derived. The heats of transfer are exactly or almost Lorentz invariant. Explicit formulae are given from which the difference between the results of the relativistic and the non-relativistic theory may easily be surveyed. The concentrations of the chemical components appear to be almost Lorentz invariant quantities. A.

536.7

2384. Thermodynamics of irreversible processes in rotating systems. G. J. HOOYMAN, H. HOLTAN, JR, P. MAZUR AND S. R. DE GROOT. *Physica,* **19,** 1095–108 (*Nov.*, 1953).

The general entropy balance equation for a rotating system containing a mixture of (charged and uncharged) components is calculated and the influence of centrifugal force and Coriolis force on the entropy production is considered. From the general formalism the equations for mechanical equilibrium are derived. As a further specification of this case, Svedberg's equations for the determination of molecular masses of uncharged particles are derived, viz. the equation for the sedimentation equilibrium and (introducing the boundary condition of vanishing volume flow) the equation for the sedimentation rate in the ultra-centrifuge. A proper definition of the diffusion coefficient is given. A.

536.7 : 518.4

2385. On obtaining thermodynamic formulae. F. MORÁN. *An. Real Soc. Españ. Fis. Quim.*, **48**(A) 271–82 (*Sept.–Oct.*, 1952) *In Spanish.*

A graphical method is proposed of deriving the thermodynamic formulae by groups, and of easily keeping in mind those which are most frequently needed. A.

536.7 : 530.162

The statistical mechanics of irreversible processes. *See Abstr.* 2048

536.7 : 538.566

On the thermodynamics of electromagnetic waves. *See Abstr.* 2606

536.71

2386. On the use of the thermal equation of state of a Van der Waals gas at the critical point. T. PINTER. Note in *Naturwissenschaften*, **40**, *No.* 19, 505 (1953) *In German.*

The energy of a Van der Waals gas at the critical point is considered and it is shown that the kinetic, potential and total energies are in the numerical ratio 4 : 3 : 1. The potential energy for a pair of molecules in argon is calculated and compared with that deduced from the Lennard–Jones equation.

F. E. HOARE

536.71

2387. Gas theory. XVI. Basic curve and derived curves. State of the gas at high temperatures. J. DUCLAUX. *J. Phys. Radium*, **14**, 497–501 (*Oct.*, 1953) *In French.*

For previous part, see *J. Chim. phys.*, **50**, 113 (1953). The method of calculation of the basic curve applicable in the author's theory of progressive association [Abstr. 8564 (1950)] is given and that for the derived isothermals. The variation with temperature of certain factors used in the derivations is examined and it is concluded that as $T \rightarrow \infty$ the gas tends to a limiting state which is not that of a perfect gas and which differs from one gas to another. The method of extending the isothermals to temperatures inaccessible to experiment is outlined. F. E. HOARE

536.71

2388. Some remarks on the equation of state and the energy of quantum-liquids at the critical point. J. VAN DRANEN. Letter in *J. chem. Phys.*, **21**, 2095–6 (*Nov.*, 1953).

A previously proposed hypothesis regarding the critical point [Abstr. 8127 (1952), 4057 (1953)] is examined in relation to various modifications of the Van der Waals equation. It is shown that none of these satisfy the hypothesis and it is concluded that it is impossible to obtain a simple quantitative equation of state which does. Where there is large zero-point energy, as for hydrogen and helium, this has to be taken into account and the hypothesis enables it to be calculated. Results so obtained are in good agreement with those calculated from the interpolation formula of London. F. E. HOARE

536.75

2389. Thermodynamics of mixtures of liquids differing in molecule size. Heats of mixing of the system benzene-diphenyl. G. KORTÜM, G. DREESEN AND H.-J. FREIER. *Z. Naturforsch.*, **8a**, 546–55 (*Sept.*, 1953) *In German.*

Total heats of mixing have been measured at 71·6°C for the system C_6H_6–$(C_6H_5)_2$ over the whole mole-fraction range; they can be expressed within the accuracy of measurement by a single-constant equation for regular mixtures. The differential heats of mixing, calculated from this equation and from the coefficients of activity for C_6H_6 found in literature, yield the differential supplementary entropies of mixing, the values of which are compared with those obtained from the theory of athermal mixtures. Considerable discrepancies found between theory and experiment are tentatively explained. The technique of accurate calorimetric measurements at high temperatures is described in detail. F. LACHMAN

536.75

2390. On the least production of entropy by transmission of heat. P. GLANSDORFF. *Physica*, **19**, 1029–34 (*Oct.*, 1953) *In French.*

The author points out the difficulties presented by the ordinary method for finding the minimum of entropy creation, especially when the phenomenological coefficients cannot be considered as mere constants, being functions of state. An application is made of a general method for finding the minimum [Abstr. 1277 (1953)], and this confirms Prigogine's prevision according to which the minimum of entropy creation does correspond to the steady state of the system under consideration. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

2391. Experiments on the *g*-factor of the electron. F. BLOCH. *Physica*, **19**, 821–31 (*Sept.*, 1953).

Two main groups of experimental methods are discussed. The first consists of experiments, already carried out, with bound electrons: measurement of the hyperfine structure of hydrogen and measurement and comparison of atomic *g*-factors. These confirm the calculated value to first order in α, the experimental error being of the same order of magnitude as the second-order correction. The second group are proposed experiments on free electrons in a magnetic field: effect on the polarization of electrons, and magnetic resonance of slow electrons. G. FIELD

537.12 : 538.113

Effect of the surface on the magnetic properties of an electron gas. *See Abstr.* 2564

ELECTROSTATICS. DIELECTRICS 537.2

537.21

2392. Application to the case of the cube of a method for calculating the excess and the defect of the electrostatic capacity of a conductor. L. DABONI. *R.C. Accad. Naz. Lincei*, **14**, 461–6 (*April*, 1953) *In Italian.*

Polya and Szegö showed that the capacity C, of the unit cube, satisfies $0{\cdot}632 < C < 0{\cdot}71055$. Various improvements have since been given. That now announced is $0{\cdot}645 < C < 0{\cdot}676$. This is obtained by more accurate mathematical analysis.

L. S. GODDARD

537.213 : 621.317.723

2393. A vibrating needle electrometer. Y. L. Yousef and R. Kamel. *J. sci. Instrum.*, **31**, 13–15 (*Jan.*, 1954).

A dynamic type of mechanical electrometer, incorporating a simple electronic circuit, is described. The underlying principle is that the electrostatic force due to the charge under test is modulated by a small periodic component so that, instead of merely deflecting the suspended system, which in this case is simply a metallic reed, it sets it also into resonant vibrations the amplitude of which is proportional to the charge, and may be easily measured directly on an output indicator. The electrometer can be used in a null arrangement in which the reed vibrations are prevented by an opposing voltage. The electrometer capacity is 3·9 pF, and the output indication per volt is 0·25 V readable to 0·005 V. A theory is given and the applications are discussed. A.

537.221

2394. Static and dynamic measurement of electromotive forces. W. J. Poppelbaum. *Helv. phys. Acta*, **26**, *No.* 5, 489–98 (1953) *In French.*

Generalizes the relationships between the electric field and heat flow on the one hand and the heat gradient on the other, derived for a conductor by Meixner [*Ann. Phys.*, **35**, *No.* 5, 701 (1939)]. As a result of this generalization, phenomena such as induction, thermoelectricity and chemical processes are grouped together. By distinguishing between the voltaic and galvanic potentials, the author obtains a simple treatment of the "contact potential differences" known from static e.m.f. measurements. F. LACHMAN

537.221

2395. Electron-exit potentials of pure and oxygen-coated Au, Pt and Pd, evaluated from their voltaic potentials against Ag. J. Giner and E. Lange. Note in *Naturwissenschaften*, **40**, *No.* 19, 506 (1953) *In German.*

See Abstr. 5096 (1952). An improved version of the previously described apparatus has been used for measuring the potentials of metal pairs in abraded form. Assuming the value 4·74 V for the electron-exit potential of Ag, the following electron-exit potentials have been determined for pure and O-coated metals: Au, 4·74; Pt, 5·25; Pd, 5·07; Cd, 4·43; "AuO," 5·94, 5·64, 5·64; "PtO," 6·45, 6·35, 6·35; "PdO," 5·97, 6·32 V. F. LACHMAN

537.226

2396. On the theory of dielectric breakdown in ionic crystals. H. Fröhlich. *Rep. Brit. Elect. Res. Assoc., Ref. L/T277*, 14 *pp.* (1952).

The method previously developed in the theory of dielectric breakdown of amorphous materials [Abstr. 4053 (1950)] is applied to pure crystals. It yields a theoretical upper limit for the breakdown strength. A.

537.226 : 539.13

2397. On the reaction field of polar liquids. T. G. Scholte. *J. chem. Phys.*, **21**, 2087 (*Nov.*, 1953).

The author mentions that Frood and Dekker's [Abstr. 6491 (1952)] computation of the reaction field of spherical molecules with an eccentric dipole moment is a special case of the general problem of a spherical particle with an arbitrary distribution of charge in a homogeneous dielectric [see also the author's thesis, University of Leiden, 1950; and C. J. F. Böttcher, *Theory of electric polarisation*, p. 94 (1952)]. F. LACHMAN

537.226.1

2398. The extension of Fröhlich's general theory of the static dielectric constant to anisotropic materials. J. G. Powles. *Rep. Brit. Elect. Res. Assoc., Ref. L/T269*, 10 *pp.* (1952).

Fröhlich's general theory of the static dielectric constant is extended to the case of anisotropic materials. It is pointed out that the more detailed information can be obtained with little extra labour in the event of the approximate isotropic calculation being practicable. A.

537.226.2

2399. Dielectric constants of some hydrated crystals. J. Chapelle and A. Galy. *J. Chim. phys.*, **50**, C 44–C 45 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. Low frequency dielectric constants of $BaCl_2 . 2H_2O$, $Li_2SO_4 . H_2O$, $BeSO_4 . 4H_2O$ and $C_2O_4H_2 . 2H_2O$ from 100–400°K are given graphically. They show sharp rises at high temperatures before the H_2O is driven off. D. H. WHIFFEN

537.226.2

2400. Dispersion in ammonia in 3 cm region. Krishnaji and P. Swarup. *Z. Phys.*, **136**, *No.* 3, 374–8 (1953).

Variation in the electric susceptibility of ammonia with pressure was studied at several wavelengths in the 3 cm region by standing wave technique using an experimental cell of 3 m length. The experimental values have been compared with those theoretically calculated on the basis of the quantum mechanical formula for dispersion by Van Vleck and Weisskopf suitably accounting for all the polarizations other than due to microwave inversion. The experimental values fall below the theoretical values. The value of susceptibility for ammonia at atmospheric pressure is $5·3 \times 10^{-3}$. A.

537.226.2 : 532.74

2401. The study of water molecules by radio-frequencies. J. B. Hasted. *J. Chim. phys.*, **50**, C 35–C 39 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. A review of the dielectric properties of water and ice and the explanation in terms of various numbers of non-, singly-, doubly-, triply- and quadruply-bound molecules and the rupture of the hydrogen bonds. D. H. WHIFFEN

537.226.2 : 538.565

2402. The dielectric constant of amorphous selenium at wavelengths of 1 cm and 3 cm. E. W. Saker. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 1117 (*Dec.*, 1953).

So as to determine any possible intermediate value for K between the l.f. value of 6·3 and the infrared value beyond 2 μ of 6·0, measurements were made at 3 and 1·2 cm using cylindrical cavity resonators. The mean result is $6·37_6$, essentially the same as the l.f. value, so that a change is to be expected in the long-wave infrared. A. HOGARTH

537.226.2 : 539.2

2403. Effects of contamination on structure and properties, with special reference to long-chain ketones. V. DANIEL AND C. TURNER. *Rep. Brit. Elect. Res. Assoc.*, *Ref. L/T*281, 6 *pp.* (1952).

Small amounts of impurities have a large effect on the dielectric properties of ketones. The report shows that impurities have no appreciable effect on the solid structure of the materials, but the pronounced effect on the dielectric properties is due to the fact that ketones are good solvents of impurities in the liquid state and bad solvents in the solid state. A.

537.226.2 : 539.32 : 548.0

2404. Dielectric behaviour and the elastic moduli of single crystals of ice. F. HUMBEL, F. JONA AND P. SCHERRER. *J. Chim. phys.*, **50**, C 40–C 43 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. Single ice crystals, up to 6 cm dia. 10 cm long, are grown slowly from water in several days. ε' and ε'' from 50 c/s to 20 kc/s are shown graphically for fields $\parallel$ and $\perp$ to the c axis and marked anisotropy is observed. The five elastic constants are given. D. H. WHIFFEN

537.226.2 : 621.315.612.4

2405. Time effects in the hysteresis loop of polycrystalline barium titanate. M. MCQUARRIE. Letter in *J. appl. Phys.*, **24**, 1334–5 (*Oct.*, 1953).

Over several weeks after cooling from the Curie temperature the p.f. of polycrystalline $BaTiO_3$ steadily decreases as the domains settle to a more stable configuration. The hysteresis loop shows a corresponding decrease in maximum and remnant polarization. Input of energy returns the system to a less stable state. A. L. MACKAY

537.226.3

2406. The distribution of energy in a mixture of two dielectrics in an electric field, and determination of the loss angle of the quasi-stationary process. W. NIESEL. *Ann. Phys.* [*Leipzig*] **12**, *No.* 7–8, 410–22 (1953) *In German.*

Both the mean energy per unit volume absorbed by a mixture in an electric field, and the distribution of this energy in the constituents of the mixture, are considered. Formulae are derived giving the energy distribution when a heterogeneous aggregate is suspended in a homogeneous medium, and when two heterogeneous media are mixed. Anisotropic dielectric ellipsoids are used to represent the heterogeneous aggregates. The loss angle of the mixture is derived from the energy distribution. J. H. MASON

537.226.3

2407. Water in the crystallization of maltose and glucose and states of water of sorption of starch from the radiofrequency absorption spectra. P. ABADIE, R. CHARBONNIÈRE, A. GIDEL, P. GIRARD AND A. GUILBOT. *J. Chim. phys.*, **50**, C 46–C 52 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. The experimental methods are outlined for the measurement of ε' and ε'' from 25 c/s to 24 000 Mc/s and curves given for β-maltose . H_2O, α-glucose . H_2O and starch. For crystals the loss is small but for amorphous and dehydrated materials, especially previously melted maltose, $\varepsilon'' \sim 0{\cdot}25$ and this loss disappears on benzoylation. It is due to rotation of OH groups. Dried starch shows such a loss which increases with hydration. D. H. WHIFFEN

537.226.3 : 539.133

2408. The thermal and dielectric properties of crystalline long-chain acetates. R. J. MEAKINS AND J. W. MULLEY. *J. chem. Phys.*, **21**, 1934–9 (*Nov.*, 1953).

This deals with the normal long-chain acetates with 18, 20, 24 and 28 carbon atoms. When crystallized from the melt, these compounds first give the transparent α-phase which gradually changes to the white, opaque β-phase on standing or on cooling below a certain temperature. It is found that the acetates in the α-phase all give large dielectric absorption, whereas in the β-phase the absorption is small, or, in some cases, negligible. Of the long-chain compounds so far investigated, the acetates in the α-phase are unique in giving two absorption regions which appear to be the result of the rotational transitions of complete molecules. The maxima for the two regions are separated by about 7 decades in frequency. Measurements of the lower frequency absorption at various temperatures show that the associated energy barrier is very large compared with previous values for compounds of similar chain-length. To explain these results it is suggested that a molecule rotating in the crystal lattice of a long-chain compound possesses four positions of equilibrium instead of two, as previously proposed. In addition to the two absorption regions mentioned above, the long-chain acetates in the α-phase give further absorption at still higher frequencies, which is probably caused by independent orientation of the polar groups near the ends of the molecular chains. A.

537.226.3 : 621.3.017.143 : 621.315.61

2409. Maxwell–Wagner loss and absorption currents in dielectrics. B. V. HAMON. *Austral. J. Phys.*, **6**, 304–15 (*Sept.*, 1953).

The dielectric loss factors of a number of heterogeneous mixtures have been measured at frequencies up to 3 Mc/s. The mixtures consisted of a non-polar base material and small percentages of a slightly conducting solid or liquid "impurity." Two types of dispersion of the solid impurity were studied, one using discrete spheres and the other using a fine powder covering the surfaces of large grains of the base material. For the discrete spheres, good agreement with Wagner's theory was obtained. The results for the powdered solid impurity and the liquid impurity show that such mixtures can give rise to dielectric-loss factors that increase slowly with decreasing frequency over a wide range, and finally merge with the loss due to d.c. conductivity. The mixtures also gave rise to anomalous charging currents when direct current was applied. These currents were measured, and their relation to the a.c. loss factors indicated. The behaviour of the mixtures under different d.c. and a.c. potential gradients was also studied. It was found that the steady-state d.c. conductivity increased with increasing potential gradient, but that the a.c. loss factor at a particular frequency did not change. An

explanation is suggested. The results are compared with the published data for practical dielectrics, and support the view that, at least for non-polar dielectrics, the small loss factors and d.c. charging currents frequently observed may be due to conducting impurities present as a separate phase. A.

537.226.8 : 537.32 : 536.42

2410. Theory of the thermo-dielectric effect. B. Gross. *An. Acad. Brasil Ciênc.*, **25**, *No.* 2, 175–96 (1953) *In Portuguese.*

An extended analysis of the electrical phenomena at the melting or freezing interface of an ionic compound when the transition probabilities of the positive and negative ions through the boundary layer are unequal. The electrical conductivity of the solid phase is assumed negligibly small, so that during freezing a quasi-permanent space-charge is built into the solid. The boundary layer forms an electrical double layer. Expressions are obtained for the open-circuit potential (with zero initial bias) for a uniform rate of freezing, and for the short-circuit current when the freezing is suddenly held up, and the currents during freezing and melting are discussed. 28 refs.

F. F. ROBERTS

537.226.8 : 539.374 : 548.0

2411. Plastic deformation and the electric strength of alkali halide crystals. R. Cooper and A. A. Wallace. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 1113–15 (*Dec.*, 1953).

Experiments made to test whether the mechanical stress due to the electrostatic force during testing at high voltage is sufficient to cause plastic deformation before breakdown and thereby increase the electric strength. Results suggest an electric strength of undeformed KCl crystals of $0{\cdot}6$ to $0{\cdot}7\times10^{6}$ V.cm^{-1}.

C. A. HOGARTH

537.228.1 : 534.121.1

2412. Thickness-shear and flexural vibrations of contoured crystal plates. R. D. Mindlin and M. Forray. *J. appl. Phys.*, **25**, 12–21 (*Jan.*, 1954).

An approximate method is devised for calculating frequencies of thickness-shear and flexural vibrations of crystal plates of varying thickness. Applications are made to plates having the shape of a double wedge and to plates with bevelled edges. A.

537.228.1 : 534.121.1

2413. Thickness-shear vibrations of piezoelectric crystal plates with incomplete electrodes. R. D. Mindlin and H. Deresiewicz. *J. appl. Phys.*, **25**, 21–5 (*Jan.*, 1954).

In this paper the influence of length of electrodes on thickness-shear frequencies of piezoelectric crystal plates is investigated. A.

537.228.1 : 534.121.1

2414. Suppression of overtones of thickness-shear and flexural vibrations of crystal plates. R. D. Mindlin and H. Deresiewicz. *J. appl. Phys.*, **25**, 25–8 (*Jan.*, 1954).

It is shown how electrodes, coated on the surfaces of thickness-shear plates, may be shaped so that, when the driving frequency coincides with a particular resonant frequency, only that resonant mode is excited. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 532.51

2415. Variational methods for problems in resistance. J. F. Carlson and T. J. Hendrickson. *J. appl. Phys.*, **24**, 1462–5 (*Dec.*, 1953).

Schwinger's variational methods are applied to a resistance problem with mixed boundary conditions. By the use of two formulations, both upper and lower bounds to the resistance are obtained. Results are given for a cylinder subject to given boundary conditions for a number of values of the relevant parameters. A.

537.311 : 621.315.5.066.6

2416. Fundamental processes of electrical contact phenomena. F. Llewellyn Jones. *Radio Res. Special Rep.*, *No.* 24, 66 *pp.* (1953).

A comprehensive critical survey of existing knowledge of electrical contact phenomena and of the fundamental physical processes underlying contact operation and failure for all types of contact. Failure results from (1) geometrical distortion of contact faces caused by the transfer of metal between electrodes and electrode erosion, and (2) from the reduction of the electrical conductivity of the contacting members by the formation of semi-conducting or insulating surface layers. Metal transfer and erosion are caused by spark and arc discharges (arc transfer) and by the formation and rupture of molten metal bridges (fine transfer). Each phase of contact operation is considered separately and in great detail; the processes leading to the different types of transfer during the phases are individually considered. A rigorous mathematical treatment of the role of the Thomson effect in fine transfer and the location of the maximum temperature in a contact is given. Research into the elimination of fine transfer based on investigations of the Thomson coefficient and thermal and electrical coefficients at all temperatures up to the boiling point and studies of the properties of bimetal contacts are indicated. The formation of tarnish layers of oxides, chlorides, etc., leading to failure under (2) and the role of circuit inductance, gas atmosphere, electron attachment and diffusion and their effects in contributing to the processes of failure as well as some of the mechanical features of contacts are treated. There are 79 references.

C. G. MORGAN

537.311.1 : 536.33

2417. On the theory of electrical fluctuations and thermal radiation. S. M. Rytov. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 535–8 (1952) *In Russian.*

Develops previous work [Abstr. 5466 (1953)] to show how Maxwell's equations enable the two phenomena to be related. J. M. HOUGH

537.311.3 : 535.34

2418. On the theory of optical absorption in metals and semiconductors. R. Wolfe. *Proc. Phys. Soc.* [*London*] *A*, **67**, 74–84 (*Jan.*, 1954).

A quantum-mechanical method is described for calculating the effect on the optical absorption of metals and semiconductors of any of the factors responsible for electrical resistance. In this method

he electrons which are scattered by imperfections in he crystal lattice are considered to absorb light by a photoelectric process. The calculation is carried out for the case where the conduction electrons are scattered by dissolved impurities. A first order approximation method is used. The results obtained are compared with those of the semi-classical theory used in existing textbooks, in which the current set up by the light is assumed to be damped by the impurities. It is found that the two methods give very similar results for metals. For semiconductors, on the other hand, the approximate method used here gives considerably less absorption than the semi-classical method. The use of exact wave functions for the very slow electrons in semiconductors would give greatly increased absorption coefficients because the intensity of these wave functions is high near the scattering centres. It is suggested that in this way the high absorption of the infrared radiation in semiconductors can be explained. A.

537.311.3 : 537.32

2419. Electrical properties of selenium. III. Microcrystalline selenium metal-doped. H. W. HENKELS AND J. MACZUK. *J. appl. Phys.*, **25**, 1–12 (*Jan.*, 1954).

For Pt II, see Abstr. 287 (1952). The thermoelectric powers and d.c. and 200 Mc/s resistivities of pure and metal-doped selenium have been studied as functions of temperature. The properties of materials in the two important microstructures (colony and equiaxed) were distinguished. The influences of the metals Na, Cu, Ag, Mg, Zn, Cd, Hg, Ga, In, Tl, Pb, Sb, Bi, Te, Fe, Ni, Co, and Ce were noted. A working model of the selenium semiconductor was developed. In this model there is an acceptor level $< 0{\cdot}15$ eV from the full band caused by non-metals and possibly lattice defects. In strained crystals or material in the colony structure a second acceptor level $0{\cdot}27$ eV from the full band is postulated from the behaviour of d.c. and a.c. resistivity curves as a function of temperature. The density of the first level varies in the range $10^{14}/cm^3$ to $6\times10^{16}/cm^3$ with amount of non-metal impurity. The density of the second level depends on the crystal structure, decreasing as the colony structure recrystallizes to the equiaxed. In the specimens crystallized at 110°c the density was about $2\times10^{16}/cm^3$. Both metals and non-metals are largely segregated at grain boundaries. Metals produce effective donor levels at these places. The d.c. properties reflect the presence of internal barriers produced by the segregation. The donor levels enhance barriers existing in the purest selenium tested increasing resistivities and thermoelectric powers. With increase in temperature > 160°c the density of acceptor levels decreases as defects are removed by structural changes in the lattice. A.

537.311.31

2420. Anomalous [electrical] properties of dilute alloys. J. KORRINGA. *Physica*, **19**, 816–20 (*Sept.*, 1953).

Gives a qualitative interpretation of results of experiments by Gerritsen and Linde on the electrical properties at low temperatures of dilute alloys of Mn with the noble metals [see Abstr. 8609 (1953) for a fuller discussion]. E. P. WOHLFARTH

537.311.31 : 537.323 : 538.63

2421. Measurement of the electrical resistance and thermoelectric e.m.f. of the alloy Fe_3Pt in longitudinal and transverse magnetic fields. R. G. ANNAEV AND M. V. KOLODIN. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 2, 195–6 (1953) *In Russian.*

The experiments reported earlier have been extended to show that heat treatment of the alloy can give an ordered or non-ordered system each of which has different electrical properties. When heated to 1000°c and quenched in water the longitudinal and transverse galvanomagnetic effects are of different sign, the transverse being the larger and negative. The two thermomagnetic effects are of the same positive sign in weak fields but in powerful fields the transverse changes sign and becomes negative up to 9000 oersteds when it again becomes positive. After annealing at 650°c for 100 hr and quenching in air, the signs of the longitudinal and transverse galvanomagnetic effects are still the same but the longitudinal effect is reduced. The two thermomagnetic effects are of different sign, the longitudinal becoming positive, the transverse again remaining negative up to 9000 oersteds when it changes sign. W. BARDSLEY

537.311.31 : 548.7

Lattice defects and the electrical resistivity of metals. *See Abstr.* 2863

537.311.33

2422. Semiconducting properties of zinc phosphide (Zn_3P_2). J. LAGRENAUDIE. *J. Chim. phys.*, **50**, 545–7 (*Oct.*, 1953) *In French.*

Zinc phosphide made by evaporation or in the form of compressed pellets shows photoconductivity throughout the visible spectrum dependent on mode of preparation. The photoconduction limit corresponds to the absorption edge at about $1{\cdot}1\ \mu$.

G. F. J. GARLICK

537.311.33

2423. A method of estimating impurity concentrations in germanium. F. W. G. ROSE AND E. W. TIMMINS. Note in *Proc. Phys. Soc.* [*London*] *B*, **66**, 984–6 (*Nov.*, 1953).

The variation with temperature of the resistivity of Ge with a given carrier concentration, for various total impurity concentrations (sum of donors and acceptors) was calculated, and the curves obtained were used to determine impurity content by comparison with experimental resistivity against temperature curves. J. FRANKS

537.311.33

2424. Drift mobilities in semiconductors. I. Germanium. M. B. PRINCE. *Phys. Rev.*, **92**, 681–7 (*Nov.* 1, 1953).

The drift mobility of holes in *n*-type germanium and electrons in *p*-type germanium has been measured as functions of impurity concentration and temperature. In single crystals of resistivity greater than 10 ohm-centimetre, the mobility at 300°K of poles is $\mu_P = 1900 \pm 50$ cm²/volt-sec and of electrons is $\mu_N = 3900 \pm 100$ cm²/volt-sec. For this high-resistivity material, the temperature dependence of mobility in the same units is $\mu_P = 3{\cdot}5\times10^7T^{-1{\cdot}6}$ and $\mu_N = 9{\cdot}1\times10^8T^{+2{\cdot}3}$, in agreement with conductivity-mobility measurements. A.

537.311.33

2425. Production of acceptor centers in germanium and silicon by plastic deformation. W. C. Ellis and E. S. Greiner. Letter in *Phys. Rev.*, **92**, 1061 (*Nov.* 15, 1953).

5% compression of *n*-type Ge crystals at 500°C and 650°C, and 2·5% and 18% compression of *n*-type Si at 725°C and 850°C respectively, produced about 10^{15} acceptor centres/cm^3 in the specimens. J. FRANKS

537.311.33

2426. Preparation of *p–n* junctions by surface melting. K. Lehovec and E. Belmont. *J. appl. Phys.*, **24**, 1482–4 (*Dec.*, 1953).

A new method is described for preparation of *p–n* junctions in single-crystal semiconductors: the upper part of a slice cut from a single-crystal semiconductor is melted by radiation. Impurities of the opposite type to those present in the crystal are introduced into the melt. Upon slow solidification of the melt a single crystal is obtained with a *p–n* junction at the original position of the solid-liquid interface. The method is capable of producing multiple junctions. The influence of (*a*) heater temperature, (*b*) forced cooling, and (*c*) thickness of the slice on the position of the solid/liquid interface is calculated for a one-dimensional model, assuming that the temperature difference between bottom and top of the semiconductor is small compared to the melting temperature of the semiconductor. The time constant characterizing the rate of reaching equilibrium conditions after a sudden small change in heater temperature is estimated. A.

537.311.33

2427. A note on the semiconducting compound InSb. F. A. Cunnell, E. W. Saker and J. T. Edmond. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 1115–16 (*Dec.*, 1953).

Polycrystalline *n*-type InSb, purified by zone melting under vacuum and annealed at 350°C, was prepared having a conductivity of 33 ohm^{-1} cm^{-1}, the electron concentration being less than 10^{16} cm^{-3}. The intrinsic activation energy is 0·38 eV. Annealing may greatly increase carrier mobility. J. FRANKS

537.311.33

2428. Mobility of impurity ions in germanium and silicon. J. C. Severiens and C. S. Fuller. Letter in *Phys. Rev.*, **92**, 1322–3 (*Dec.* 1, 1953).

For Li the diffusivities are given by $D = 25\times10^{-4}$ exp $(-11\,800/RT)$ for Ge, and by $D = 19\times10^{-4}$ exp $(-14\,700/RT)$ for Si, in the range 150–851°C, suggesting that Li diffuses as Li^+. It is established that Cu migrates as a positive ion but the exact charge is not known. C. A. HOGARTH

537.311.33

2429. The temperature dependence of the drift mobility of injected holes in germanium. R. Lawrance. *Proc. Phys. Soc.* [*London*] *A*, **67**, 18–27 (*Jan.*, 1954).

The drift mobility of holes in *n*-type germanium was studied as a function of temperature. In the temperature range 100°K to 300°K the mobility varies as $T^{-2\cdot3}$ except when it is dominated by trapping. The effect of trapping on the mobility was investigated, and a suitable trapping model suggested. A.

537.311.33

2430. Some problems in the diffusion of minority carriers in a semiconductor. S. Visvanathan and J. F. Battey. *J. appl. Phys.*, **25**, 99–102 (*Jan.*, 1954).

The exact solutions to the problems of the diffusion or minority carriers involved in the measurement of surface-recombination velocity in a semiconductor with a sample geometry bounded by two infinite planes are presented. The reduction of the exact solutions to simple forms used in the analysis of experimental data is shown. A.

537.311.33 : 538.63

2431. On the electrical properties of InSb. H. Weiss. *Z. Naturforsch.*, **8a**, 463–9 (*Aug.*, 1953) *In German.*

Gives results of measurements of electrical conductivity, Hall effect and magnetoresistance effect on six samples of InSb with different impurity concentrations. The measurements extended from −210°C to 450°C. Two of the samples were *p*-type at low temperatures, becoming *n*-type at higher temperatures and with an activation energy in this region of about 0·5 eV. At room temperature the maximum electron mobility [Hall] observed was 41 000 cm^2/volt sec and the largest change of resistance in a field of 10 000 oersteds was 15%. A. E. DE BARR

537.311.33 : 548.7

2432. Observation of cyclotron resonance in germanium crystals. G. Dresselhaus, A. F. Kip and C. Kittel. Letter in *Phys. Rev.*, **92**, 827 (*Nov.* 1, 1953).

In a 38 ohm.cm *n*-type crystal, at 4°K and at a frequency of 9050 Mc/s, the resonance was observed at a field of 370 oersted, corresponding to an effective mass $m^*/m = 0\cdot11$. The relaxation time, as determined from the width of the resonance (100 oersted) was $0\cdot7\times10^{-10}$sec. The dependence of the signal on power was consistent with an avalanche ionization of shallow traps. In a *p*-type crystal with 10^{14} acceptors/cm^3 two resonances were observed: (*a*) at 125 oersted ($m^*/m = 0\cdot04$) with a half-width of 50; (*b*) at 970 oersted ($m^*/m = 0\cdot30$) with a half-width of 100. No shift in resonance position with orientation of the magnetic field was observed. L. PINCHERLE

537.311.33 : 548.7

2433. The propagation of electrons in a strained metallic lattice. S. C. Hunter and F. R. N. Nabarro. *Proc. Roy. Soc. A*, **220**, 542–61 (*Dec.* 22, 1953).

This is studied by a perturbation technique in which the perturbing potential is proportional to the elastic strain and not, as in the usual treatment, to the displacement. For slowly varying strains the perturbing potential is a deformation potential of the type introduced by Bardeen and Shockley [Abstr. 1057 (1951)], in which the periodicity of the lattice does not appear explicitly. In the approximation of nearly free electrons, the contribution of the ionic lattice to the deformation potential depends only on the dilatation and not on the shear components. This potential is modified by a flow of electrons from the

compressed regions of the lattice to the expanded regions. The resulting potential depends only on the Fermi energy of the electrons and not on their interaction with the lattice of ions. In a higher approximation, the effective mass of the electrons depends on their interaction with the ionic lattice. The contribution of this term is comparable with that already considered, and the shear components of the strain also influence the deformation potential. The method is applied to estimate the electrical resistivity produced by dislocations of edge and screw types present in sodium and copper. In copper screw dislocations add appreciably to the total resistivity.

A.

537.311.33

2434. Theoretical resistivity and Hall coefficient of impure germanium near room temperature. P. G. Herkart and J. Kurshan. *R.C.A. Rev.*, **14**, 427–40 (*Sept.*, 1953).

The temperature variation of resistivity over the range −100°c to +140°c has been calculated and plotted for both *n*-type and *p*-type germanium with different impurity content, ranging from 0·1 ohm-cm to 60 ohm-cm at 25°c. When germanium is first purified and then intentionally doped with a single impurity, it is desirable to know the relationship between actual impurity content and resistivity or Hall coefficient. Ordinarily, with reasonably perfect crystals, resistivity can be used to specify impurity; on the other hand, for highly doped material or if crystal perfection is uncertain, the Hall coefficient is a more reliable index. These relationships have been calculated for 25°c and are plotted, again for both *n*- and *p*-types. The curves can be used either to predict electrical values from known impurity content, or to interpret measured electrical values in terms of germanium analysis. A.

537.311.33 : 621.314.63

2435. Production of a *p*-type CdS rectifier by high local heating of *n*-type crystals. G. Strull. Letter in *J. appl. Phys.*, **24**, 1411 (*Nov.*, 1953).

Rectification effects for contacts on *n*-type CdS crystals after high local heating by a point heated to about 850°c are measured. In some cases the polarity of the crystals change but the change disappears after gentle warming or slightly prolonged passage of a current. C. A. HOGARTH

537.311.33 : 621.314.7

2436. Forming silicon point contact transistors. H. Jacobs, F. A. Brand and W. Matthei. Letter in *J. appl. Phys.*, **24**, 1340 (*Oct.*, 1953).

n–p–n and *p–n–p* transistors were formed by pressing small quantities of suitable impurity between a W electrode and Si sample and passing a large current. A table is given of the characteristics of *p*- and *n*-type Si before and after processing. J. FRANKS

537.311.35 : 532.77

2437. A model of metal–ammonia solutions, with reference to electron spin resonance experiments. J. Kaplan and C. Kittel. *J. chem. Phys.*, **21**, 1429–33 (*Sept.*, 1953).

An explanation is given of the extreme sharpness of the electron spin resonance line in solutions of potassium in liquid ammonia, as reported by Hutchison and Pastor [Abstr. 8563 (1953)]. Motional narrowing of the width associated with dipolar and hyperfine interactions results from the rotation and diffusion of ammonia molecules. The model of metal-ammonia solutions used in the calculation is shown to be supported by thermal, magnetic, volumetric, and conductivity data. The model pictures the electrons removed from the potassium atoms as located in cavities in the liquid, the cavities having approximately the volume of two to four ammonia molecules. The electrons in the cavities are in equilibrium with respect to the reaction $2e \lesssim e_2 + 0{\cdot}2$ eV, where e_2 represents two electrons in a singlet state in one cavity. The electrons in cavities may perhaps be thought of as in molecular orbital states on the protons of the adjacent NH_3 molecules. A.

537.311.4

2438. Electrical contact resistance between magnetically attracted bodies. C. W. Wilman. Letter in *Nature* [*London*] **172**, 917–18 (*Nov.* 14, 1953).

Results of experiments on light current contacts indicate that the resistance at a contact in which the members are attracted to each other by a magnetic force is less than that between members pressed together mechanically by a force of the same magnitude. Reasons are given for attributing this to a greater number of minute areas of actual contact in the case of magnetic attraction. M. R. HOPKINS

537.311.62

2439. On the transient period of the skin effect. D. Zanobetti. *R.C. Accad. Naz. Lincei*, **14**, 791–5 (*June*, 1953) *In Italian.*

A co-axial cable of infinite length is considered. The inner conductor may or may not be hollow. A sinusoidal p.d. is applied at $t = 0$. The current at any time is derived by means of a Laplace transformation. The formulae appear amenable to ready numerical evaluation. L. PINCHERLE

537.312.5

2440. Photoconductivity of CdS monocrystals and its enhancement by added illumination. V. E. Lashkarev, V. C. Medvedev, A. I. Skopenko, G. A. Fedorus and M. K. Sheĭnkman. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 5, 905–7 (1952) *In Russian.*

Attention called to phenomenon of enhancement of sensitivity of CdS in 1950. Present work investigates spectral distribution of effects with combined pulsed light and steady light. Diagram given to illustrate spectral sensitivity both with constant wavelength of steady light (in fundamental band 5050 Å) and with constant wavelength of pulsed light. Claimed that experiments permit rejection of idea that observed decrease of sensitivity towards shorter wavelengths due to creation of large numbers of carriers and hence to larger rate of recombination. If so then adding constant illumination to pulsed light could only reduce sensitivity instead of increasing it 100 to 1000 times as it does. Shown that in region 4000 Å to 2400 Å CdS crystals have constant quantum efficiency. Using W lamp the sensitivity is 35–50 mA/L/V. The linear response extends to currents of up to 100 μA (with 100 V). Dark resistance 10^{12} ohms. Light/dark resistance = 10^{-6}. Fatigue

inappreciable in visible and u.v. Large crystals 10 to 600 times more sensitive than very small ones described by Kolomiets [Abstr. 5473 (1953)]. J. EWLES

537.312.5

2441. Photomultipliers and the detection of nuclear particles. H. DORMONT AND E. MORILLEAU. *Vide*, **8**, 1344–52 (*May*, 1953) *In French.*

Discusses the requisite properties of photomultipliers for particle counting (spectral variations of sensitivity to match the crystal radiations, stability of gain, short transit time, etc.), gives data for the 931 A and EMI type 5060 tubes, and finally gives an account of a new photomultiplier for nuclear expts. (LEP.MT 11). J. D. CRAGGS

537.312.5

2442. Photoconductivity of indium selenide. D. E. BODE AND H. LEVINSTEIN. *J. Opt. Soc. Amer.*, **43**, 1209–10 (*Dec.*, 1953).

Indium selenide layers were formed by successive evaporations of indium and selenium and by direct evaporation of indium selenide. The films are photoconductive with a long wavelength cutoff at about $2\,\mu$ and peaks in their spectral response at $0{\cdot}6$ and $1{\cdot}4\,\mu$. A different time constant is associated with each peak. In the visible region the time constant is greater than 1 msec, while in the infrared it is generally less than 100 μsec. A.

537.312.62

2443. On the lattice vibration and the effective mass of conduction electrons. H. KANAZAWA, S. KOIDE AND T. NOGUCHI. *Progr. theor. Phys.*, **9**, 288–94 (*March*, 1953).

The effective mass of electrons interacting with lattice vibrations is calculated by means of the second-order perturbation theory. The result is that the magnitude of the effective mass of electrons near the Fermi surface is of the order of $10^{-3} \sim 10^{-4}m$, irrespective as to whether the distribution of electrons is normal or superconductive. The effect of small effective mass on the diamagnetic susceptibility of electrons is discussed. A.

537.312.62

2444. Transition temperatures of superconductors. B. T. MATTHIAS. *Phys. Rev.*, **92**, 874–6 (*Nov.* 15, 1953).

Superconductivity has been found in a number of new compounds between the non-superconducting transition elements and non-metals such as Si, Ge and Te. These findings have suggested possible criteria for superconductivity in both elements and compounds. A.

537.312.62 : 538.632

2445. Search for the Hall effect in a superconductor. I. Experiment. H. W. LEWIS. *Phys. Rev.*, **92**, 1149–51 (*Dec.* 1, 1953).

A search has been made for a Hall effect in superconducting vanadium, using a new method that avoids some of the difficulties previously encountered. The result is negative, with an upper limit of 150×10^{-6} e.m.u., which can be compared with the value of 800×10^{-6} e.m.u. for normal vanadium. The theoretical implications will be discussed in a separate paper. A.

537.32 : 536.48

2446. Thermoelectricity at low temperatures. G. BORELIUS. *Physica*, **19**, 807–15 (*Sept.*, 1953).

Experimental curves are constructed, giving the absolute thermoelectric powers of Sn, Pb, Ag, Cu down to very low temperatures, and showing the marked effect of impurities. At present no adequate theoretical explanation of these curves can be given. P. M. DAVIDSON

537.32 : 536.48

2447. Thermoelectric power in metals at low temperatures and anomalous impurity scattering. D. K. C. MACDONALD. *Physica*, **19**, 841–5 (*Sept.*, 1953).

Recounts briefly recent experimental results from the author's laboratory. C. A. HOGARTH

537.32 : 536.7

2448. On the theory of thermocouples and thermocells. H. HOLTAN, JR, P. MAZUR AND S. R. DE GROOT. *Physica*, **19**, 1109–18 (*Nov.*, 1953).

The thermodynamical theory of irreversible processes is applied to thermocouples and thermocells, and a general expression for the thermopotential is derived. In the derivations absolute material flows and a reduced heat flow have been used. The thermopotential consists of four parts, viz. two "heterogeneous" potential differences (between the electrodes and the electrolyte) and two "homogeneous" potential differences (in the wire and in the electrolyte). The general expression for the thermopotential can be split up into two parts, one containing essentially entropies of transfer and one containing known quantities (entropies and transference numbers). This latter part can be calculated and, from comparison with experimental results, conclusions as to the magnitude of the first part can be drawn. A.

537.35

2449. On the electrical conductivity of hydrogen bonded binary liquid systems. T. S. BRUN. *Univ. Bergen Arbok*, **1952**, *No.* 12, 94 *pp.*

Very careful measurements of electrical conductivity using forms of the Wheatstone bridge and the Schering bridge for higher resistances have been made as well as viscosity measurements (which were ingeniously performed in the conductivity cell in some cases). A number of systems were investigated and the results correlated with a literature survey covering the period 1917–1950. It is shown how a number of properties must depend on hydrogen bonding as well as on composition and the relation $S = x\eta V^2$ shown to be true. x = electrical conductivity; η = viscosity; V = molal volume of the mixture; $S = Ax^m(1 - X)^n$ where A is an empirical parameter, x and $1 - x$ are the mole fractions of the two components, while m and n are integral, being the number of molecules in the characteristic structural unit for the interaction of the two components. For the complicated systems examined at such high concentrations the results are in extremely good agreement with the formulae put forward; possible reasons for this are discussed. There is an extensive list of references. T. C. TOYE

ELECTRIC DISCHARGES 537.52

537.521

2450. Investigation of the impulse breakdown of gases and the velocity of development of electron showers. B. M. Gokhberg, I. S. Stekol'nikov and A. Z. Éfendiev. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 1, 29–32 (1952) *In Russian.*

An experimental investigation on the way in which the striking potential for a gas depends on both the pressure and the duration of the electrical impulse when its duration is of the order of 10^{-8} sec. Experiments on air and SF_6 show that below a certain impulse duration no discharge occurs and that this time is a linear function of the plate separation; this is explained in terms of the time needed for an electron shower to form and hence a velocity of development can be calculated. It is shown that this velocity is a linear function of the electric field per unit pressure. The recorded velocities of shower formation are of the order of 10^7 cm/sec. J. M. HOUGH

537.523/.525/.527

2451. Electrical breakdown of gases. J. M. Meek and J. D. Craggs. *Oxford: Clarendon Press* (1953) 507 *pp.*

A comprehensive reference book which summarizes the results of a wide range of recent experiments on electrical discharges and the theories developed to attempt to account for them. The book itself presents the picture as it appeared in 1951, but an appendix summarizes the more important papers which appeared up to the end of 1952. The fundamental processes which occur in discharges are first considered, and the Townsend theory outlined by consideration of primary and secondary ionization coefficients. Breakdown voltage characteristics at high and low pressures (including vacuum) for various gases and gap geometries and for both steady and impulse d.c., a.c. and high-frequency fields are discussed. Experimental results on the growth of spark discharges, as observed by means of records of the light output and by oscillograph and Lichtenberg figure studies, are given, and a chapter is devoted to studies of the lightning discharge. The streamer theory of breakdown is detailed and some objections to it noted. The formative and statistical time lags of breakdown, and the effect of irradiation and surface conditions on the latter are discussed. The concluding chapters are concerned with the development and properties of spark channels, electrode effects in established discharges and glow-to-arc transitions.

J. DUTTON

537.523.4 : 535.338.3

2452. The spectrum of predischarges in very long sparks. F. Rimbert and A. Vassy. *C.R. Acad. Sci.* [*Paris*] **237**, 1324–5 (*Nov.* 23, 1953) *In French.*

Describes time resolved spectroscopy (1 mm ≡ 5 μsec on the photographic film) of predischarges in sparks, i.e. the pre-breakdown regimes. For sparks in air, various O and N lines are listed. J. D. CRAGGS

537.523.5 : 537.527.5

2453. On high-current arcs at very high temperatures and with very low burning voltages. G. Busz and W. Finkelnburg. Note in *Naturwissenschaften*, **40**, *No.* 21, 550–1 (1953) *In German.*

Describes, in outline, expts. with short argon and nitrogen arcs in which the total discharge voltage is less than the first excitation potential of the gas. Electrode vapour generally is not observed in the discharges, which carry currents varying from about 20 to 500 A. Excitation temps. are ~35 000°K.

J. D. CRAGGS

537.525

2454. Measuring energy emitted by electrically activated nitrogen. H. Cygan. *Acta phys. Polon.*, **11**, *No.* 2, 189–94 (1952).

Rayleigh's work [Abstr. 1222 (1947)] on the measuring of energy emitted by electrically activated nitrogen was repeated, and the causes of the very high values of energy he obtained were studied. It is concluded that the results obtained by Rayleigh may be easily explained. A.

537.525.5

2455. Some measurements on a not selfsustaining gas discharge, with an axial magnetic field. J. Kistemaker and J. Snieder. *Physica*, **19**, 950–60 (*Oct.*, 1953).

The potential distribution inside the central arc column was measured using a new type of hot probe technique, with differential probe currents. Very deep negative potential troughs were found in case of electronegative gases (O_2, Cl_2). In the oscillating electron type of discharge the troughs are much deeper than in case of a normal magnetic arc, e.g. 90 V with $V_{anode} - V_{cathode} = 100$ V. In general the central plasma potentials for electropositive gases (A, H_2, N_2) are still negative in comparison with the anode potential. This is in striking contrast with results of former investigations using the technique of probe characteristics, which usually lead to positive plasma potentials, relative to the anode cylinder (arc chamber). The depth of the potential trough was investigated as a function of the arc current, the pressure and the concentration of various gas mixtures. A.

537.525.5 : 537.525.8

2456. Spectroscopic study of caesium discharges in a magnetic field. L. W. Davies. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 898–9 (*Oct.*, 1953).

Measurements of the electron-ion recombination radiation enabled radial variations of electron densities in Cs discharges (0·087 mm Hg, 2·5 A current) to be found. D.C. and h.f. (6 Mc/s) discharges were studied, with and without a 1200 gauss longitudinal field in the h.f. case. J. D. CRAGGS

537.525.8

2457. Seat of the Joshi effect in a.c. silent discharges. P. S. V. Setty, K. Kulkarni and C. M. Srivastava. *Indian J. Phys.*, **26**, 455–62 (*Sept.*, 1952).

Some experiments on the positive and negative Joshi effects in "sleeve" discharge tubes containing iodine vapour and hydrogen gas were performed to study the effect of illuminating the different parts of each discharge tube successively by a narrow beam of strong light. The results have shown that the

Joshi effect (positive and negative) is associated predominantly with the regions of the electrodes. The role of the discharge column of the tube in the production of the Joshi effect, if any, is, however, regarded as uncertain. The effect of stray light affecting the electrodes after being scattered from the illuminated part of the discharge tube is considered in discussing the experimental results of Agashe. A.

537.525.8

2458. A study of afterglows in helium excited at centimetre wavelengths. J. JANIN AND I. EYRAUD. *C.R. Acad. Sci.* [*Paris*] **237,** 1073–5 (*Nov.* 2, 1953) *In French.*

The helium was excited with a 40 kW magnetron at 3 cm wavelength; the pulse duration was 2 μsec. Time resolved spectroscopy showed that atomic and molecular radiations were present, with important temporal differences. J. D. CRAGGS

537.527.4

2459. On the initiation of electric sparks in compressed gases. A. BOULLOUD. *Ann. Phys.* [*Paris*] **8,** 909–65 (*Nov.–Dec.*, 1953) *In French.*

The paper covers pressures up to about 60 kg/cm^2, with special reference to discharges in air. The introduction stresses the importance of the electrodes (cathode in d.c. discharges) above, say, 10 kg/cm^2 pressure. These results are discussed in terms of various theories, and space charge effects, etc., are considered. Then measurements of pre-breakdown currents in uniform field conditions are described, leading to a detailed consideration of field emission, including the importance of surface roughness, which appears to be of predominant importance in the breakdown process although there are complicating factors, such as the effect of space charges. 77 refs. J. D. CRAGGS

537.527.8

2460. The high-pressure glow discharge in air. W. A. GAMBLING AND H. EDELS. *Brit. J. appl. Phys.*, **5,** 36–9 (*Jan.*, 1954).

Describes observations using copper and tungsten electrodes and gives characteristics for discharge lengths from 1 to 8 mm and currents from 0·01 to 0·5 A. Measurements of the current density at the cathode and in the positive column are given and a method of estimating the cathode-fall voltage is discussed. A.

537.528 : 541.135

2461. Special characteristics of the anodic spark in spark electrolysis. P. BARRET. *C.R. Acad. Sci.* [*Paris*] **237,** 1084–6 (*Nov.* 2, 1953) *In French.*

Describes, with experimental details, sparking phenomena obtained between a Pt sphere of 1 mm diameter and the surfaces of various aqueous solutions of NaCl, Na_2CO_3 and KCl. These are recorded by means of oscillograms and cinematographic registration. No evidence of thermionic emission is obtained, and the cathodic fall is stabilized around an abnormal value of 700 V. Cathodic pulverization of the electrolyte modifies the usual appearance of the spark. The new characteristics are discussed. H. H. HODGSON

537.529

2462. The influence of cathode material on the electric strength of potassium bromide crystals. R. COOPER AND D. T. GROSSART. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66,** 716–17 (*Aug.*, 1953).

Results of Alger and von Hippel [Abstr. 585 (1950)] are possibly due to differences in pre-treatment of the crystals rather than to different cathode materials. I. D. L. BALL

X-RAYS 537.531

537.531

2463. On the distribution of X-radiation with depth in an anti-cathode. R. CASTAING AND J. DESCAMPS. *C.R. Acad. Sci.* [*Paris*] **237,** 1220–2 (*Nov.* 16, 1953) *In French.*

A method of determining the intensity distribution of X-rays with depth by using a composite anti-cathode of layers of copper and a thin layer of zinc and measurements of the absorption of the primary electron beam are described. Possible interpretation of results is given. C. G. MORGAN

537.531 : 535.33.07 : 548.736.3

2464. Some atomic planes in quartz suitable as lattices in X-ray spectroscopy. G. BROGREN AND L. E. HAEGGBLOM. *Ark. Fys.*, **6,** *Paper* 18, 171–6 (1953).

See Abstr. 2898. The spacings of the planes $11\bar{2}2$, $20\bar{2}3$, $30\bar{3}1$, $22\bar{4}3$ and $50\bar{5}2$ were determined in terms of the Cu $K\alpha_1$ or Mo $K\alpha_1$ wavelength. The wavelengths of Zn $K\alpha_1$ and Zn $K\alpha_2$ were measured in terms of the $11\bar{2}2$ spacing. A. R. STOKES

537.531 : 535.345

2465. Various absorption coefficients for 23·5-MeV X-rays. W. S. MOOS, W. J. HENDERSON AND J. W. BEATTIE. *Science*, **118,** 300–1 (*Sept.* 11, 1953).

Figures are given for water, glass, $ZnBr_2$, lead glass and lead. F. T. FARMER

537.531 : 535.42 : 537.533.73 : 533.7 : 532.7

On measurements of interatomic distances in gases and liquids by electron and X-ray diffraction methods. *See Abstr.* 2081

537.531 : 535.43

2466. Dispersion of X-rays in the region of the *K* and *L* [absorption] edges of heavy atoms. H. EISENLOHR AND G. L. MÜLLER. *Z. Naturforsch.*, **8a,** 429–32 (*July*, 1953) *In German.*

Following the wave-mechanical method of Hönl [*Ann. Phys.* (*Leipzig*) **18,** 625 (1933)] the authors have calculated scattering curves for tellurium (52) and tungsten (74), showing anomalies around the *K* and *L* absorption edges. Agreement is obtained with some measured values. A. R. STOKES

537.531 : 539.153

Precision determination of the *K* excitation potentials of some 3*d* elements. *See Abstr.* 2685

537.531 : 539.165

2467. Characteristic X-rays from thick β-ray sources. K. LIDÉN AND N. STARFELT. *Ark. Fys.*, **7,** *Paper* 18, 193–6 (1953).

The intensities of characteristic X-ray lines excited

by β-particles were measured for the systems P^{32} + Pb radiator, P^{32} + Sn, S^{35} + Sn. From these curves and from absorption data, the intensity ratio of the *K*-radiation to that of the continuous bremsstrahlung is calculated. L. PINCHERLE

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 541.183.26

2468. Field emission and gas adsorption. F. KIRCHNER. *Z. angew. Phys.*, **5**, *No.* 8, 281–3 (1953) *In German.*

A field emission microscope incorporating a fine wire mesh between the point cathode and anode screen is described. Photographs showing changes in the emission picture from tungsten caused by the adsorption of gases are discussed. C. G. MORGAN

537.533

2469. Space charge effects in field emission. J. P. BARBOUR, W. W. DOLAN, J. K. TROLAN, E. E. MARTIN AND W. P. DYKE. *Phys. Rev.*, **92**, 45–51 (*Oct.* 1, 1953).

A progressive reduction of the observed field current below values expected from the empirical law for increasing values of the potential is attributed to space charge. The current density expected in the presence of space charge is calculated from the Fowler–Nordheim field emission theory using values of the cathode electric field obtained from a solution of Poisson's equation for plane electrodes with boundary conditions appropriate to field emission. The result is a generalization of Child's equation, and is asymptotic to it when the applied potential is large compared with the value required for appreciable field emission. Current densities predicted by the theory are compared with experimental values obtained for several values of the work function by use of the clean tungsten and the barium-on-tungsten emitting surfaces in high vacuum. The Fowler–Nordheim theory correctly predicts the observed average current density from clean tungsten for densities in the range from 2 amp/cm^2 to 4×10^7 amp/cm^2, thus extending a previous test of the theory which was limited to current densities less than 6×10^6 amp/cm^2. Significant features of the electron emission pattern observed at high current densities are explained as effects of space charge. A.

537.533

2470. Work function in field emission. Chemisorption. R. GOMER. *J. chem. Phys.*, **21**, 1869–76 (*Oct.*, 1953).

Analogues to the contact potential are calculated for the work function increase in field emission caused by polar chemisorbates. It is found that the discreteness of the dipoles constituting the layer leads to a work function increment smaller than the corresponding contact potential. The discrepancy becomes more marked at low coverages and high fields. A simple Fermi–Thomas calculation for estimating the depolarization of the electron cloud at a metal surface is given. It is probable that observed depolarizations of oxygen and nitrogen on tungsten can be explained in terms of this factor. The effect of the high fields used in cold emission on the work function is estimated and found to be of the order of 0·1 volt. Arguments are presented to show that a recent explanation of the fall in heats of chemisorption with coverage may need revision. A.

537.533

2471. Field emission current-density distribution. W. P. DYKE, J. K. TROLAN, W. W. DOLAN AND F. J. GRUNDHAUSER. *J. appl. Phys.*, **25**, 106–13 (*Jan.*, 1954).

A quantitative measurement of the current-density distribution over the surface of monocrystalline tungsten field emitters is obtained by densitometric analysis of calibrated photographic negatives of emission patterns observed with a modified Mueller projection tube. Analysis of distributions thus obtained permits an improved evaluation of average field current density and a confirmation of the surface distribution of electric field previously derived; an earlier comparison of experiment with field emission theory is thus strengthened. Current-density ratios for various crystal faces of the emitter confirm recent values of the work function for those faces. Emission patterns were viewed on an aluminium backed phosphor, the advantages and fabrication of which are discussed. Relative light output from such phosphors is presented for excitation by field currents at various values of the applied potential for both steady state and microsecond operation. A.

537.533 : 615.849 : 621.384.613

2472. High-power betatron for cancer therapy. J. S. LAUGHLIN, J. OVADIA, G. SHAPIRO AND Z. ABDUN-NABI. *Electronics*, **26**, 146–51 (*Oct.*, 1953).

Details of the Sloan Kettering 24 MeV betatron as a source of electrons and X-rays are given. A rapid flux change at injection is used to prevent electrons striking the back of the cathode, and the orbit is expanded after 1·4 msec for either the target or magnetic shunt, as required. Energy output is measured calorimetrically, and photographic records of dose distribution for both electrons and X-rays are given. F. T. FARMER

537.533.7

2473. On the penetration of electrons. E. CLEMENTEL. Letter in *Nuovo Cimento*, **10**, 683–5 (*May*, 1953) *In Italian.*

An approximate solution is given, in the form of a complex integral, of the integro-differential equation for the probability $P(E_0, E, t)$ that an electron of initial energy E_0 should have energy between E and $E + dE$ after traversing t radiation units. L. PINCHERLE

537.533.7

2474. The straggling of fast electrons. S. KAGEYAMA, K. NISHIMURA AND Y. ONAI. Note in *J. Phys. Soc. Japan*, **8**, 682–3 (*Oct.*, 1953).

The experimentally determined energy distribution of 1414 keV electrons after passing through 12 mg/cm^2 of Al was found to be in agreement with that calculated from the theory of Blunck and Leisegang [Abstr. 2728 (1951)]. J. HUGHES

537.533.7 : 538.569.2

2475. Energy loss of moving electrons to dipolar relaxation. H. Fröhlich and R. L. Platzman. *Phys. Rev.*, **92**, 1152–4 (*Dec.* 1, 1953).

The relation between energy loss of a moving charged particle and dielectric loss in an insulator is analysed, and a formula giving the rate of energy loss to dielectric relaxation of an electron traversing a dipolar medium is deduced. For an electron having kinetic energy lower than the lowest electronic excitation potential, this interaction makes a substantial contribution to the total energy loss, one often comparable to the loss to molecular or lattice oscillations. Possible applications in physics and in radiobiology are mentioned. A.

537.533.7 : 621.385.833

2476. Space-charge waves in inhomogeneous electron beams. G. Kent. *J. appl. Phys.*, **25**, 32–41 (*Jan.*, 1954).

A magnetically confined sheet electron beam filling the space between two plane parallel electrodes is discussed. It is assumed that the average electron space charge is not neutralized by positive ions so that the potential at the centre is depressed, and the beam is inhomogeneous in velocity and charge density. The objective of this theoretical treatment is to determine whether or not exponentially growing space charge waves can be supported by such a beam. For small inhomogeneity and continuous behaviour of all quantities as functions of the inhomogeneity, it is shown that growing waves are not possible. This conclusion is supported by discussion of the analogous adjacent beam problem and the analogous velocity distributed filamentary beam. Although the adjacent beams can support growing waves, it is argued that the analogy is not valid because the adjacent beams cannot be obtained by a continuous perturbation of a single homogeneous beam. The analogy of the velocity distributed beam does not suffer from this deficiency. In this case it is shown that growing space charge waves cannot exist unless the distribution function has more than one relative maximum. A.

537.533.72

2477. "Brillouin flow" with thermal velocities. J. R. Pierce and L. R. Walker. *J. appl. Phys.*, **24**, 1328–30 (*Oct.*, 1953).

A type of electron flow in a constant magnetic field is described. The beam of electrons is supposed to be everywhere in thermal equilibrium and the usual Brillouin flow is found when the equilibrium temperature tends to zero. Some considerations are put forward bearing on the choice of a suitable beam temperature in specific problems. A.

537.533.72

2478. On the chromatic resolving power of electron lenses used for velocity analysis. F. Lenz. *Optik*, **10**, *No.* 9, 439–46 (1953) *In German.*

The chromatic aberration in rotational symmetric lenses is evaluated in relation to the results of Möllenstedt. For V = 40 kV the limit of resolving power is $\simeq 0{\cdot}03$ V for electrostatic and 1 V for magnetic lenses. However, for a source at 2700°K the initial thermal fluctuations are at least $0{\cdot}23$ V, so they will normally be the limiting factor in electrostatic lens systems. A. H. W. Beck

537.533.72

2479. On the determination of the electron-optical characteristics of electrostatic lenses. II. W. Lippert and W. Pohlit. *Optik*, **10**, *No.* 9, 447–54 (1953) *In German.*

For Pt I, see Abstr. 1678 (1953). Further results on the lenses treated in Pt I are given, including the image distortion, spherical aberrations, the variation of lens power and position of focal plane with the potential of the centre electrode. Experimental results are compared with results deduced from a simplification of the formulae due to Regenstreif. Fair agreement is obtained. A. H. W. Beck

537.533.72

2480. A method for the direct measurement of the caustic surfaces in electron lenses. W. Scheffels, M. Hahn and F. Lenz. *Optik*, **10**, *No.* 9, 455–8 (1953) *In German.*

To obtain a photograph of the caustic surface an object is placed between the object lens and the further focal plane, i.e. between the objective and the screen. and near to the focal plane. The intense electron bombardment causes changes in the structure of the object, which can later be used in the normal position to obtain a picture on which the caustic surface appears as a darkened area. A collodion foil coated with colloidal silver was used as the object in the examples shown. The interpretation of the caustic figure is discussed. A. H. W. Beck

537.533.72 : 530.145.6

2481. Electron optical image formation on the basis of wave mechanics. I. W. Glaser and P. Schiske. *Ann. Phys.* [*Leipzig*] **12**, 240–66 (*July*, 1952) *In German.*

The use of wave mechanics permits a complete description of electron imaging, including phase relations as well as amplitude, whereas geometrical optics gives only the amplitude (current density) in the image. In the electron microscope many objects are so thin as to be completely transparent, so that only phase differences occur in the image, corresponding to loss of energy in passing through the object. By applying the Schrödinger equation the existence of image formation is demonstrated in the case of an electromagnetic field of rotational symmetry. The wave function in any plane transverse to the axis and in the paraxial region is expressed in terms of the form of the wave function in the object plane. It then follows that a particular plane exists in which the same distribution of electron current density occurs as in the object plane, but multiplied by a scale factor. The position and magnification of the image agree with the corresponding results of geometrical electron optics. The imaging of a slit and of a circular aperture by a typical magnetic electron lens is calculated. It is found that Fresnel diffraction fringes appear in any out-of-focus plane, and that as true focus is approached the fringes contract to give a sharp edge to the image. The magnitude of the influence of an aperture on the image is discussed, and then the imaging of periodic structures (gratings), as in the Abbe–Rayleigh light optical theory. But in contrast to optical imaging, phase effects play the predominant part in electron imaging. The results of the calcula-

tions are well illustrated with diagrams of the electron current density in successive planes transverse to the axis, for each type of object. V. E. COSSLETT

537.533.72 : 530.145.6

2482. Electron optical image formation on the basis of wave mechanics. II. W. GLASER AND P. SCHISKE. *Ann. Phys.* [*Leipzig*] **12,** 267–80 (*July*, 1953) *In German.*

The methods of Pt I are extended to the non-paraxial region of a lens with a given electromagnetic imaging field. The wave function in any arbitrary plane of focus is determined from its form in a given plane (the object plane) with the aid of Green's function. In this way the analogue of Kirchhoff's diffraction equation is obtained for the region over which the field extends, leading to a consistent wave mechanical theory of the image aberrations in electrostatic and magnetic electron lenses. General expressions for the aberration coefficients are given; no attempt is made to evaluate numerically the aberrations produced by a focusing field of given distribution. V. E. COSSLETT

537.533.72 : 530.145.6

2483. The motion of a "wave packet" in an electron lens. W. GLASER. *Öst. Ingen.-Arch.*, **7,** *No.* 2, 144–52 (1953) *In German.*

Image formation by an electron lens is discussed by wave-mechanical methods. The Schrödinger equation is obtained for paraxial electron motion in an electromagnetic field, and integrated to give a general solution for the wave function in the object plane. The solution is applied to the case of an electron "object-spot" of elliptical shape in which the intensity (current density) falls off along both axes according to a bell-shaped distribution curve. The current density in any subsequent plane is then derived from the solution for the wave equation in that plane. The result, physically expressed, shows that the wave packet keeps together during its passage through an electron lens, although it changes in cross-section, in contrast to the indefinite expansion which it would undergo in field-free space. The lens action is such as to localize the wave packet and to guide it along the path given by geometrical optics. The cross-section of the wave-packet at first increases in the lens, reaches a maximum near its centre and then decreases to a value at the image plane that is M times that in the object plane, where M is the magnification. In the paraxial case the distribution in each plane has the same (elliptical) form. This variation in cross-section is mathematically discussed in terms of the interaction of the classical motion and Heisenberg's uncertainty relation. V. E. COSSLETT

537.533.72

2484. Are atoms and molecules visible in the microscope? P. CHANSON. *Cahiers de Phys.*, *No.* 46, 44–57 (*Nov.*, 1953) *In French.*

The possibilities of making atoms or molecules visible are reviewed. The optical microscope is ruled out. X-ray methods can be used to give reconstructions of the electron density distributions in the molecules of regular crystals. The electron microscope is quoted as being limited by spherical aberration to a resolving power of 20 Å, although possible methods of overcoming this limitation are discussed. The possibility of seeing atoms is limited by contrast conditions, and the destructive effect of electron radiation. The proton microscope with a theoretical resolution of 1 Å is discussed. M. E. HAINE

537.533.72 : 537.533.73

2485. A combination of electron microscopy and diffraction. S. YAMAGUCHI. Note in *Naturwissenschaften*, **40,** *No.* 21, 551 (1953).

The focusing of electron microscope images becomes difficult when their level of illumination is low, for instance, with a semi-opaque specimen or at very high magnification. A method of "blind" focusing is proposed, in which the high voltage supply is connected to both the magnetic electron microscope and an electron diffraction apparatus (without electron lenses) in parallel. The focusing current in the magnetic objective lens is inversely proportional to the root of the voltage and the radius of a given diffraction ring (e.g. of gold) is also inversely proportional to the root of the voltage, for fixed positions of the specimens in the two instruments. A calibration curve can thus be made of ring radius against lens current, and the lens current needed for exact focus found by direct observation of a standard specimen in the electron microscope. Blind focusing at low illumination on another specimen may then be carried out by careful observation of the diameter of the diffraction ring in the parallel apparatus. The method may have particular value where a specimen is very sensitive to electron bombardment. V. E. COSSLETT

537.533.72 : 537.533.73

2486. A photographic plate airlock for electron-optical instruments. H. BETHGE AND K. H. BRAUER. *Optik*, **10,** *No.* 8, 399–403 (1953) *In German.*

The paper describes a photographic plate air lock suitable for electron diffraction cameras and electron microscopes. For a plate size of 6 cm × 6 cm, the unwanted volume of air to be pumped is only 15 cm^3. The arrangement described differs from previous designs in that the plate transporting mechanism is worked solely by a lever. The air lock door is in the form of a wedge and uses bonded rubber for the vacuum seal. A.E.I. RESEARCH LABORATORY

537.533.72 : 539.163.2

2487. The design and operation of a double magnetic lens beta-ray spectrometer. G. P. RUNDLE, J. ELLIS, T. C. GRIFFITH AND H. S. TOMLINSON. *Proc. Phys. Soc.* [*London*] *B*, **67,** 52–64 (*Jan.*, 1954).

Both coils of this spectrometer are capable of very fine adjustment in five degrees of freedom. Extensive work has been carried out on the testing of the instrument. This has included a study of the variation of spherical aberration with coil separation, the use of a quick and accurate experimental method of plotting trajectories and an investigation of the extremely critical nature of coil alignment. Experimental confirmation of the predictions of Deutsch and his co-workers has also been obtained, and ring focus has been incorporated with notable success.

This spectrometer has a much lower spherical aberration than a short lens and gives a performance comparing not unfavourably with long lens types. A.

537.533.72 : 539.163.2

2488. Realization of a magnetic-lens spectrometer. Study of the radiation of Au^{198} and As^{76}. P. HUBERT. *Ann. Phys.* [*Paris*] **8,** 662–708 (*Sept.–Oct.*, 1953) *In French.*

The section dealing with optimum arrangement of stops amplifies Abstr. 4854 (1953); graphs are given showing the effect of source size on resolution. The work on correction of spherical aberration is not carried beyond Abstr. 4839 (1953). The lens briefly mentioned in Abstr. 324 (1952) is described in detail; the gathering power now claimed is 2·0%. "Overall gathering power" [defined in paper reported in Abstr. 3561 (1951)] is 1·4% for 2 mm dia. source, 1·85% for 6 mm, 1·95% for 10 mm. The practical method of setting stops to take advantage of intermediate ring focusing is described. The γ-rays from Au^{198} were studied by measuring electrons from a Pb radiator; results were given in Abstr. 8175 (1951). Internal conversion was only detected for the 411 keV γ-ray, the K conversion coefficient being measured as $3{\cdot}0 \pm 0{\cdot}1$, the $(L + M)$ coefficient as $1{\cdot}5 \pm 0{\cdot}1$. From a Fermi plot, referring to measurements made with a source of 0·16 mg cm^{-2}, the upper limit of the continuous β-spectrum was found to be 965 ± 5 keV. A decay shceme is proposed. γ-ray data for As^{76} are those given in Abstr. 1205 (1952). β-γ coincidence measurements confirm that the most energetic component of the β-spectrum (near whose upper limit there is a curvature on the Fermi plot) is not in coincidence with any of the γ-rays. γ-γ coincidence measurements agree with one of the 3 decay schemes which have been proposed. J. C. E. JENNINGS

537.533.73

2489. Electron diffraction. Z. G. PINSKER [Translated by J. A. SPINK AND E. FEIGL.] *London: Butterworths Scientific Publications*, xiv + 443 *pp.*

Review in *Brit. J. appl. Phys.*, **5,** 45 (*Jan.*, 1954), "... first appeared in Russian in 1949."

537.533.73 : 533.7 : 537.531 : 535.42 : 532.7

On measurements of interatomic distances in gases and liquids by electron and X-ray diffraction methods. *See Abstr.* 2081

537.533.73 : 535.42

2490. Analogies between the diffraction of light and electron diffraction. II. Study of the molecules Cl_2O and NO_2. M. PÉREZ RODRÍGUEZ, R. VEGÁ AND J. M. GARCÍA GARCÍA. *An. Real. Soc. Españ. Fís. Quim.*, **49(A)** 5–6 (*Jan.–Feb.*, 1953) *In Spanish.*

For Pt I, see Abstr. 1380 (1954). Gives a new experimental proof of the method described previously. It has been applied with success to the molecules of Cl_2O, ClO_2 and NO_2. A.

537.533.73 : 535.42

2491. Analogies between the diffraction of light and electron diffraction by gas molecules. III. Non-rigid molecules. L. BRÚ, M. PÉREZ RODRÍGUEZ AND R. VEGA. *An. Real. Soc. Españ. Fís. Quim.*, **49(A)** 87–90 (*March–April*, 1953) *In Spanish.*

For Pt II, see preceding abstract. It is shown here that the analogy can be extended to molecules with internal motion. The method is applied to CO_2 and CCl_4 molecules. A.

537.533.74

2492. Phase-shift calculation of high-energy electron scattering by nuclei. D. R. YENNIE, R. N. WILSON AND D. G. RAVENHALL. Letter in *Phys. Rev.*, **92,** 1325–6 (*Dec.* 1, 1953).

Calculations for uniform nuclear charge distributions in the case of gold and of copper and for an exponential distribution for gold are carried out. The incident electrons are of energy 150 MeV in the case of gold and 224 MeV with copper. G. E. BROWN

537.533.8

2493. Energy loss of a charged particle moving in an anisotropic medium. A. KOLOMENSKIĬ. *Dokl. Akad. Nauk SSSR*, **86,** *No.* 6, 1097–9 (1952) *In Russian.*

Energy losses in the form of Cherenkov radiation and polarization are calculated by a classical method. Both effects are found to be changed strongly by introduction of an anisotropy. The calculation is carried out explicitly for a single-axis crystal. G. E. BROWN

537.533.9 : 537.534.9

2494. Electronic and ionic impact phenomena. H. S. W. MASSEY AND E. H. S. BURHOP. *Oxford: Clarendon Press* (1952) xviii + 699 *pp.*

Review in *Proc. Phys. Soc.* [*London*] *A*, **66,** 851 (*Sept.*, 1953).

537.533.92

2495. Interaction of electrons with solids. O. GLEMSER AND G. BUTENUTH. Note in *Naturwissenschaften*, **40,** *No.* 19, 508–9 (1953) *In German.*

If in an electron microscope thin slices of $KMnO_4$ are hit by electrons, the reaction products contain penta- and hexa-valent manganese. If the K shell of the Mn is ionized, then the energies of the corresponding X-rays must give information about the necessary ionization energy. The wavelengths of the K series of Mn are 2·1015, 2·0975, 1·9062 Å, which correspond to about 6000 eV, and this value is indeed just the optimum potential to be applied for this process. If the intensity of radiation is strongly increased, ionization also occurs at other values, e.g. 50 000 V. The nature of the reaction product also depends on the intensity of radiation. A. J. TAYLOR

537.533.92

2496. Specific ionization [I] produced by positrons and electrons. R. R. ROY AND M. ETIENNE. Letter in *Nature* [*London*] **172,** 953 (*Nov.* 21, 1953).

This was measured for 0·18 to 0·96 MeV particles in N and A using an automatic Wilson cloud chamber. Graphs show that I in N is the same for both particles and agrees satisfactorily with theoretical values, but that I in A may be lower for positrons than for electrons. J. DUTTON

537.533.92 : 537.534.8

2497. Instrumentation and experimental procedure for studies of electron ejection by ions and ionization by electron impact. H. D. HAGSTRUM. *Rev. sci. Instrum.*, **24,** 1122–42 (*Dec.*, 1953).

Four different instruments are described. Three have been or are being used in studies of electron ejection from metal surfaces by positive ions. A

fourth has been used in the study of the ion optics employed and in studies of ionization and dissociation of diatomic molecules by electron impact. Basic design features and performance characteristics are discussed with particular emphasis placed upon the steps taken to assure proper ion beam characteristics at the final focus. Experimental procedures are also described among which those having to do with the vacuum and adsorption of gas on the target are considered to be especially important. Auxiliary apparatus and the determinations of contact potential and work function are discussed briefly. The interpretation of data obtained with these instruments is also examined. A.

537.534

2498. On overcoming the critical energy in a synchrotron with strong focusing. E. BODENSTEDT. Note in *Z. Naturforsch.*, **8a**, 502–3 (*Aug.*, 1953) *In German.*

A qualitative discussion is given of the phase stability in the strong focusing synchrotron.

J. HUGHES

537.534

2499. The scattering of protons by residual gas in the strong-focusing cosmotron. J. SEIDEN. *C.R. Acad. Sci.* [*Paris*] **237**, 1075–7 (*Nov.* 2, 1953) *In French.*

The mean amplitude of vertical oscillations produced by gas-scattering in strong-focusing synchrotrons is investigated. It is found that this amplitude is higher than in the case of the corresponding "normal" synchrotron. Relativistic effects are briefly considered.

J. H. FREMLIN

537.534

2500. Ion trajectories in the omegatron. C. E. BERRY. *J. appl. Phys.*, **25**, 28–32 (*Jan.*, 1954).

The equations of motion in an idealized two-dimensional Omegatron are solved for the general case of arbitrary initial velocity and arbitrary starting time. A simple picture of the paths is obtained by use of a rotating co-ordinate system. A.

537.534 : 621.384.612

2501. Proton synchrotron of the University of Birmingham. *Nature* [*London*] **172**, 704–6 (*Oct.* 17, 1953).

See Abstr. 1871 (1951). This machine is now in operation, accelerating protons up to 1000 MeV. The protons circulate in an orbit of 900 cm diameter, in a magnetic field which rises from zero to 12500 gauss in 1 sec and then drops to zero, the cycle being repeated every 10 sec. A Cockcroft–Walton generator injects a pulse of protons into the orbit at 460 keV when the magnetic field reaches the appropriate value, and these are given increments of 200 eV by the r.f. accelerator, at each revolution. The r.f. increases from 330 kc/s to 9·3 Mc/s during the cycle and the protons make about 5×10^6 revolutions before reaching maximum energy. The size of a signal induced on an insulated plate at the bottom of the vacuum chamber, each time the bunched beam passes, indicates that each pulse contains about 10^8 protons. Tracks of π-mesons have been obtained in nuclear emulsions exposed nearby.

L. R. SHEPHERD

537.534.72

2502. A new mass spectrometer without a magnetic field. W. PAUL AND H. STEINWEDEL. Note in *Z. Naturforsch.*, **8a**, 448–50 (*July*, 1953) *In German.*

The ions move in the z-direction in an alternating electric field with a potential distribution of the form

$$\phi(x, y, t) = \frac{U + V \cos \omega t}{a^2} \frac{(x^2 - y^2)}{2}$$

generated between four hyperboloidal electrodes. The stability of the particle orbits is discussed. J. HUGHES

537.534.74

2503. Proton-proton scattering and the pseudoscalar meson theory. C. C. BANERJEE. *Indian J. Phys.*, **27**, 173–82 (*April*, 1953).

A study of the p-p scattering in the light of pseudoscalar meson theory using Born approximation. The theoretical findings have been numerically tested for energies of 150, 240, 340 MeV. The analysis indicates that either the pseudoscalar theory or a combination of the central and tensor force term of the interaction is unable to explain the isotropy in scattering observed experimentally. A.

537.534.74

2504. Elastic scattering of Po alpha particles on hydrogen. M. K. JURIĆ. *Bull. Inst. Nuclear Sci. "Boris Kidrich,"* **3**, 7–17 (*Aug.*, 1953).

This was investigated using photographic plates to detect the scattered α-particles. The results are in agreement with the more accurate experiments on p-α scattering. J. HUGHES

537.534.74

2505. Proton-proton scattering for a nucleon isobar model. F. T. SOLMITZ. *Phys. Rev.*, **92**, 164–72 (*Oct.* 1, 1953).

High-energy proton-proton scattering is calculated for a static interaction which includes coupling to excited nucleon states. The spin and isotopic spin dependence is taken from the strong coupling approximation of the charge-symmetric pseudoscalar meson theory; for the space dependence the Yukawa potential is used. The parameters of the interaction are chosen to fit the low energy p-p scattering data. The calculated high-energy scattering cross-section is strongly anisotropic and thus in sharp conflict with the experimental results. A.

537.534.74

2506. Alpha-alpha scattering from 12·88 to 21·62 MeV. F. E. STEIGERT AND M. B. SAMPSON. *Phys. Rev.*, **92**, 660–4 (*Nov.* 1, 1953).

The differential scattering cross-section of α-particles on helium has been investigated as a function of energy in the range from 12·88 to 21·62 MeV. The data obtained indicate a very strong angular dependence. This further appears to be a fairly sensitive function of energy. At the lower excitations there is a rather singular interference between the Coulomb and nuclear interactions. Above 20 MeV, interferences among the various components of the nuclear phase shifts again give rise to marked singularities. These data have been analysed with respect to the phase shifts arising from the angular momentum components of the interaction. This decomposition indicated resonances at 7·55 and 10·8 MeV with widths, Γ of 1·2 MeV in each case and state assignments of 0 and 4, respectively. A.

537.534.74

2507. The multiple scattering of 7·5 MeV deuterons in metals. A. Ashmore and A. V. Crewe. *Proc. Phys. Soc.* [*London*] *A*, **66**, 1172–5 (*Dec.*, 1953).

Measurements have been made in a range of metallic elements from aluminium to gold. Satisfactory agreement was obtained between the experimental distributions and those calculated from Molière's theory. The heavy elements do not show discrepancies similar to those observed in the multiple scattering of electrons and μ-mesons with relativistic velocities in lead. A.

537.534.75

2508. Stopping power of nuclear emulsions C-2 for alpha particles. J. Catalá, J. Aguilar and F. Busquets. *An. Real. Soc. Españ. Fis. Quim.*, **48**(A) 326–7 (*Nov.–Dec.*, 1952) *In Spanish.*

This was found for α-particles from 2·5 up to 19 MeV. The method is based on the well-known values of energies and ranges for those particles in the emulsion and in standard air. A.

537.534.75 : 778.3

2509. Stopping power of nuclear emulsions C-2 for protons. J. Catalá, F. Senent and J. Aguilar. *An. Real. Soc. Españ. Fis. Quim.*, **48**(A) 209–10 (*July–Aug.*, 1952) *In Spanish.*

Starting from the experimental curves $R = f(E)$, for protons in C-2 research emulsions, the stopping power of the emulsion was determined at different energies up to 13 MeV, relative to standard air. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

2510. A high frequency ion source for a 250 kV neutron generator. J. de Beauregard. Letter in *J. Phys. Radium*, **14**, 547–8 (*Oct.*, 1953) *In French.*

A source is described with an auxiliary magnetic field in the region of the extraction canal. A deuteron beam of 250 μA is obtained for an r.f. input of 60 W. J. HUGHES

537.542

2511. A method for obtaining a beam of pulsed ions by deflection modulation of a continuous beam. C. Cassignol. *C.R. Acad. Sci.* [*Paris*] **237**, 710–11 (*Oct.* 5, 1953) *In French.*

A method for the conversion of a continuous ion beam, such as obtained from a van de Graaff accelerator, into a pulsed beam is described. The beam is deflected through an angle by a varying electric field so as to vary the angle of incidence into a 180° magnetic deflector system. It is shown that, if apertures are arranged at the input and output of the 180° deflector, pulses are obtained at the output. The shape and duration of these pulses depends in a specified manner on the rate of deflection and the aperture sizes. M. E. HAINE

537.542

2512. The temperature dependence of the working of Geiger–Müller counters. O. Stanisz. *Acta phys. Polon.*, **11**, *No.* 2, 140–5 (1952).

Measurements were made on self-quenching argon-alcohol G.–M. counters in the range of temperatures between −22° and +60°C. The results show that the characteristic curves remain normal up to the temperature at which the quenching vapour begins to condense, and all changes in these curves can be explained by the assumption that the only phenomenon which causes them is the condensation of the quenching vapour. A.

537.542

2513. Counters with external cathode. M. Celma, J. A. García Fité and R. Segovia Torres. *An. Real. Soc. Españ. Fis. Quim.*, **49**(A) 7–14 (*Jan.–Feb.*, 1953) *In Spanish.*

The output signal of external cathode counters is equal to the output signal of the same counters with internal cathode. This result is obtained from the equivalent circuit of the counter. Construction details and measured dead times are given. A.

537.542

2514. An error in the correction formula for the dead time of a Geiger–Müller counter. S. J. Wyard. Letter in *J. sci. Instrum.*, **30**, 389 (*Oct.*, 1953).

The investigation, made with a probe type of quenching unit [Abstr. 2561 (1949)] shows that corrections must be made to the usual formula and are necessary because of effects due to the input coupling condenser. J. D. CRAGGS

537.542

2515. Some remarks about the discharge mechanism in Geiger counters. S. A. Korff. Note in *Rev. sci. Instrum.*, **24**, 1071–2 (*Nov.*, 1953).

Gives a discussion of two quantities which are important in Geiger counter operation, namely (*a*) transit times of electrons across the counter to the wire, and (*b*) the velocity of propagation of the discharge by a step-wise photoionization mechanism. J. D. CRAGGS

537.542 : 539.166.08 : 539.165.08

Beta- and gamma-ray spectrometer with proportional counter. *See Abstr.* 2709

537.542 : 621.387.424

2516. A battery-operated Geiger–Müller counter. G. Hepp. *Philips tech. Rev.*, **14**, 369–76 (*June*, 1953).

In the design of small portable Geiger counter instruments a low current consumption is of considerable importance; the smaller types of dry battery can then be used. This is achieved very successfully if the voltage for the counter tube is supplied by a blocking oscillator delivering voltage pulses which are employed to charge a capacitor in conjunction with a diode. The blocking oscillator functions only when a count in the Geiger tube withdraws some of the charge from the capacitor. An instrument has been constructed along these lines, measuring only $17 \times 4 \times 10$ cm and weighing 520 g, the batteries being of the kind employed in hearing-aids. Some of the requirements to be met by the circuit components are discussed, and the article also describes the circuit associated with the measuring instrument, which is calibrated in terms of the number of ionizing particles reaching the counter tube. The circuit is specially designed to ensure low battery drain. A.

537.542

2517. Radio-carbon dating by a proportional counter filled with carbon dioxide. H. DE VRIES AND G. W. BARENDSEN. *Physica*, **19**, 987–1003 (*Oct.*, 1953).

A technique is described for the measurement of the natural activity of C^{14} in a CO_2-filled proportional counter. The following experimental details are discussed: the characteristics of the counter, the influence of gas pressure on the working voltages and on the counting rates, the effect of electronegative impurities, the background, the chemical procedure, the counter tubes, the electronic apparatus and finally the possible sources of errors. The efficiency of the counter is 100% in the sensitive part. The counting rate due to fresh carbon is 5·6/min, whereas the background is 3·9/min. At present the counter contains CO_2 at 3 atm. but the measurements indicate that it will be possible to increase the pressure at least up to about 15 atm. Up to now 30 samples have been dated. A.

537.542

2518. Variations in the β-particle counting properties of diamond. N. G. TROTT. *Proc. Roy. Soc. A*, **220**, 498–513 (*Dec.* 22, 1953).

The electrical counting response of nine small type 2 diamonds to RaE β-particles has been examined at room temperature and in the temperature range 288 to 610°K. At room temperature five of the diamonds could be very strongly activated by β-particle irradiation; in the activated state the counters did not polarize in the dark, even when operated for long periods at constant field. The counting efficiency in the activated state was estimated. Deactivation could be produced by irradiation with white light. The counting rate of activated diamonds varied considerably with temperature. For heating rate of about $1{\cdot}5°K\ min^{-1}$ counting rate maxima were found in several specimens at temperatures of approximately 300 and 400°K. An attempt has been made to estimate the depths of traps believed to be responsible for these maxima; the values obtained are about 0·5 and 0·8 eV. It is suggested that the activation process may be attributed, in part, to trap saturation. A.

537.542 : 548.7

Texture of counter diamonds. *See Abstr.* 2865

537.542

2519. Resolving power of the scintillation counter for energy measurement of relativistic particles. Y. KOH. Note in *J. Phys. Soc. Japan*, **8**, 678–80 (*Oct.*, 1953).

The characteristics of a *p*-terphenyl–xylene scintillation counter excited by cosmic-ray μ-mesons ($E > 430$ MeV, zenith angle $< 7°$) are investigated for different scintillator thicknesses (photomultiplier window immersed in scintillator). Pulse distribution curves agree well with the Landau theoretical curves but displacement occurs for large scintillator thickness due to absorption of emission in the xylene.

G. F. J. GARLICK

537.542

2520. The efficiency of the anthracene scintillation counter. D. K. BUTT. Note in *Proc. Phys. Soc.* [*London*] *A*, **66**, 940–4 (*Oct.*, 1953).

537.542 : 535.376

Scintillations in CsI and γ-spectrometry. *See Abstr.* 2329

537.542 : 537.312.5

2521. The application of multiplier photocells to scintillation counting. R. B. OWEN. *Trans Instrum. Meas. Conf.*, **1952**, 139–43.

537.542 : 539.165.08

The use of two scintillation counters in beta ray spectroscopy. *See Abstr.* 2708

537.542 : 539.166.08

2522. An anticoincidence gamma-ray scintillation spectrometer. R. D. ALBERT. *Rev. sci. Instrum.*, **24**, 1096–101 (*Dec.*, 1953).

A new type is described, designed to suppress signals arising from incident photons that are not completely absorbed in the primary detecting NaI(Tl) crystal. When an undesired signal is detected by means of a cluster of NaI(Tl) crystals surrounding the primary crystal, it is removed through the discriminating action of an anticoincidence electronic gate. Under conditions of good discrimination, this type of arrangement offers the advantage of yielding the γ-ray spectrum directly without any interpretation of results which might become laborious, particularly if the incident γ-radiation has a complex spectrum. Results are presented that illustrate the discrimination action of the device by means of photographic representations of the scintillation γ-ray spectra of Cs^{137} and Na^{22}. A.

537.542

2523. Spark counters. F. BELLA AND C. FRANZINETTI. Note in *Nuovo Cimento*, **10**, 1461–79 (*Oct.*, 1953).

Describes experiments made to investigate the main characteristics of spark counters. Pt I gives details of the construction, and the experimental results. In Pt II the experimental results are discussed. A.

537.542 : 538.53 : 621.373.444

2524. Ferro-resonant trigger circuit applicable to electronic calculating machines. J. GARCÍA SANTESMASES. *An. Real. Soc. Espan. Fis. Quim.*, **48(A)**, 171–4 (*May–June*, 1952) *In Spanish.*

A new type of trigger circuit based on parallel ferroresonance is described. Experimental results with Deltamax and Mumetal are given. A.

537.542 : 621.387.424 : 621.319.3

2525. A stabilized cascade high voltage [source] for use with Geiger–Müller counters. F. HAWLICZEK. *S.B. Österr. Akad. Wiss. IIA*, **161**, *No.* 7–8, 219–27 (1952) *In German.*

Describes in some detail the characteristics (regulation, etc.) of a cascade h.t. generator (about 2 kV) for use with Geiger counters using selenium rectifiers and neon tube stabilized input.

J. D. CRAGGS

537.542 : 621.374.3

2526. A device for measuring pulse spectra. S. D. MUŽDEKA. *Bull. Inst. Nuclear Sci. "Boris Kidrich,"* **3**, 75–81 (*Aug.*, 1953).

A 50-channel pulse selector is described in which the pulses are lengthened and applied to one pair of plates of a c.r.t. The pulse also triggers an exponential time base and modulates the c.r.t. beam,

both the amplitude of the time base and the brightness of the beam being independent of pulse amplitude. The traces are recorded photographically and contours of constant density indicate the spectrum. Circuit details are incomplete. D. R. CHICK

537.542 : 621.374.32

2527. Pulse height analyzer. J. W. THOMAS, V. V. VERBINSKI AND W. E. STEPHENS. *Rev. sci. Instrum.*, **24,** 1017–20 (*Nov.*, 1953).

Uses conversion of pulse amplitude to time. Accuracy, resolution, linearity and stability are better than 1%. It can be exposed to pulse rates of several thousand per sec, records on tape up to 50 pulses per sec and is equivalent to a 250-channel discriminator. A.

537.542

2528. A compact rear-illumination system for cloud chambers. E. W. COWAN. *Rev. sci. Instrum.*, **24,** 1104–6 (*Dec.*, 1953).

The use of cylindrical mirrors made of bent plate glass results in a rear-illumination system for cloud chambers that is compact and gives good contrast with more than adequate light intensity. A small balloon-borne cloud chamber using this system requires only 6 j of energy for the light, using a lens opening of *f* 40. The mirrors are made in an inexpensive way from plate glass by heating the glass and allowing it to sag into a mould of the proper shape. A.

537.543 : 621.385.833

2529. Approximate electrode shapes for a cylindrical electron beam. E. R. HARRISON. *Brit. J. appl. Phys.*, **5,** 40–1 (*Jan.*, 1954).

For a parallel cylindrically symmetrical electron beam, in which the current is space-charge limited, the accelerating electrodes have varying shapes which previously have been determined with the electrolytic tank. With the aid of some approximations a simple equation is obtained for the shapes of such electrodes. The errors involved are a maximum for the cathode surface; for most other electrodes it is found that this equation gives results indistinguishable from those determined experimentally, and can therefore be used in the design of those electrodes for which there are no data. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

2530. A method for measuring the ionisation time of gases. H. TORGERSEN. *K. Norske. Vidensk. Selsk. Forhandl.*, **24,** *No.* 7, 26–9 (1951).

The paper describes a microwave method in which a gaseous discharge is established in a glass tube arranged axially along a waveguide (3300 Mc/s). Gas pressures varied from 0·07 to 0·3 mm Hg and the times required to build up a plasma of arbitrary electron density were found to be $\sim$1 μsec. J. D. CRAGGS

537.563

2531. Relative intensity of ions produced by the ionization of methane in a mass spectrometer. N. DOGRAMADŽI. *Recueil Trav. Inst. Rech. Struct. Matière [Belgrade]* **2,** 21–2 (*Jan.*, 1953) *In French.*

The results obtained by the author for the masses 16, 15, 14, 13 and 12 with the aid of the Nier-type mass spectrometer differ significantly from those obtained by three other authors by means of "Consolidated"-type spectrometers. The effect of different parameters on the intensity ratios has been studied, the greatest effect being due to the change in the position of the source magnet. F. LACHMAN

537.564

2532. Negative ions from dissociation of H_2Se and H_2S by electron collision, and the electron affinity of sulphur and selenium. H. NEUERT. *Z. Naturforsch.*, **8a,** 459–62 (*Aug.*, 1953) *In German.*

Dissociation products are almost exclusively Se^- and S^-. The process, measured with a mass spectrometer, commences (appearance potential) at $2{\cdot}3 \pm 0{\cdot}3$ eV for H_2Se, and at $2{\cdot}9 \pm 0{\cdot}3$ eV for H_2S. The electron affinities are 3·5 eV for S, and 2·9 eV for Se (both approx.). For H_2Se a second smaller group of Se^- is observed at $5{\cdot}5 \pm 0{\cdot}3$ eV (appearance potential), attributed to excited ions with excitation energy almost equal to the electron affinity. F. ANSBACHER

537.564

2533. Inelastic collisions between heavy particles. I. Excitation and ionization of hydrogen atoms in fast encounters with protons and with other hydrogen atoms. D. R. BATES AND G. GRIFFING. *Proc. Phys. Soc. [London] A,* **66,** 961–71 (*Nov.*, 1953).

Born's approximation is used to calculate the cross-sections of the following processes: H^+ [or H(1*s*)] + H(1*s*) $\rightarrow$ H^+ [or H(1*s*)] + H(2*s*, 2*p*, 3*s*, 3*p*, 3*d* or *C*), where *C* represents the continuum. The results are presented mainly in graphical form. In the case of the ionizing collisions the energy distribution of the ejected electrons is also given. A.

537.564

2534. The application of variational methods to scattering by ions. II. The distorted wave approximation and the 1*s*–2*s* excitation of helium ions by electron impact. B. H. BRANSDEN, A. DALGARNO AND N. M. KING. *Proc. Phys. Soc. [London] A,* **66,** 1097–103 (*Dec.*, 1953).

For Pt I, see Abstr. 3359 (1953). Wave functions determined by the variational methods of Hulthén and Kohn are employed in the calculation of the zero order partial cross-section for the process $He^+(1s) + e \rightarrow He^+(2s) + e$ by the distorted wave, the Born and the Oppenheimer approximations. The inadequacy of the latter approximation near the threshold is disclosed. A.

537.564

2535. Ionization and fragmentation of molecules by bombardment with atomic ions. E. LINDHOLM. Note in *Proc. Phys. Soc. [London] A,* **66,** 1068–70 (*Nov.*, 1953).

A wide range of atomic ions produced in a Nier-type ion source were accelerated to an energy of 500 eV, passed into H_2S gas at 2×10^{-3} mm Hg pressure and the collision products analysed in a mass spectrometer. The cross-sections for the

production of H_2S^+, HS^+ and S^+ are tabulated, and on the basis of the known appearance potentials of these ions the transitions of the atomic ions probably responsible for the charge exchange are given.

J. DUTTON

537.568

2536. Electron-ion recombination at low pressures. S. BOROWITZ. *Commun. and Electronics*, *No.* 8, 430–5 (*Sept.*, 1953).

Summarizes the broad outlines of previous investigations in this field. J. DUTTON

537.568 : 551.510.535

Recombination coefficient in the *F*-regions of the ionosphere; a possible new process of ionization of nitrogen molecules. *See Abstr.* 2949

537.571

2537. Some aspects of the dissociation of benzene under electronic impact. J. L. FRANKLIN AND F. H. FIELD. Letter in *J. chem. Phys.*, **21**, 2082–3 (*Nov.*, 1953).

Discusses the appearance potentials of 7 ions from C_6H_6, obtained by Hustrulid, Kusch and Tate [*Phys. Rev.*, **54**, 1037 (1938)], and the possible ionization mechanisms. F. LACHMAN

537.583

2538. Boundary conditions and transit-time effects in noise phenomena. R. WIESNER. *Ann. Phys.* [*Leipzig*] **12**, *No.* 7–8, 361–78 (1953) *In German.*

A study, mainly, of the cathode-potential minimum region. The assumptions made are: (1) mean emission velocity v_0 from the cathode; (2) planar flow; (3) small signal theory. The boundary conditions for constant injection velocity are determined and the cases of pure current fluctuation and pure velocity fluctuation are discussed. For current fluctuations the diode noise voltage $\propto \omega^{-2}$ while for v fluctuations it $\propto \omega^{-1}$. The relation between the two types of fluctuation is derived in the case of complete space-charge and it is shown that when dimensions are chosen to obtain low noise, the state of complete space charge is near the limit of stability so that fluctuations of either type destroy the stability in one-half cycle. Thus, both types coexist and a relation between them is assumed such that stability is assured during the whole period of a sinusoidal fluctuation. It is concluded that, contrary to some current noise theories, the current fluctuations may not be neglected in cases of long transit times.

A. H. W. BECK

537.583 : 621.385.032.216

2539. Molded thermionic cathodes. D. MACNAIR, R. T. LYNCH AND N. B. HANNAY. Letter in *J. appl. Phys.*, **24**, 1335–6 (*Oct.*, 1953).

These cathodes consist of a layer, 0·003–0·005 in. thick, of a 70–30% mixture of nickel powder and (Ba, Sr)CO_3 compressed on to the face of a suitable nickel mount. The pressed assembly is sintered after pressing. The pulsed emission at any temperature is about 60% of that given by an oxide cathode and the moulded cathode is much more resistant to ion bombardment, oxygen poisoning, etc. Lives of 5000 hr at 851°c and currents of 0·5 Á/cm² continuous have been recorded. A. H. W. BECK

COSMIC RAYS 537.591

537.591

2540. On the applicability of the concept of range for the absorption of muons underground. M. MANDÒ AND P. G. SONA. *Nuovo Cimento*, **10**, 1275–87 (*Sept.*, 1953) *In Italian.*

The method of the range is not *a priori* justified to convert the intensity-depth relation of cosmic-rays underground into the sea level spectrum of high energy muons and vice versa, when radiation losses are to be taken into account. The pertinent diffusion equation is therefore solved in a first approximation, namely by assuming that radiation losses are a small part of the collision losses, which are assumed energy independant. It is concluded that, for a general initial energy spectrum, the range method is not correct even to first order terms only; nevertheless, in the practical case, the method comes out to be sufficiently accurate down to great depths, owing to the peculiar form of the spectrum, which happens to approach a power spectrum with the (right) exponent-3. It is believed, however, that at greater depths the first order corrections should be applied for more accurate results; but final conclusions on this point could only be reached by solving the diffusion equation exactly or at least up to second order terms.

A.

537.591.1

2541. The dependence of the relative primary and total ionizations of μ-mesons on the energy. G. P. ELISEEV, V. K. KOSMACHEVSKIĬ AND V. A. LYUBIMOV. *Dokl. Akad. Nauk SSSR.*, **90**, *No.* 6, 995–8 (1953) *In Russian.*

An ionization *v.* energy curve in the range $p/m\mu = 2$ to 40 obtained with proportional counters and a magnetic mass spectrograph under 50 cm Pb suggests the presence of the polarization effect which decreases the ionization at high energies. A special statistical method was used in estimating the most probable value from a number of counter readings.

W. J. SWIATECKI

537.591.1

2542. Flux determination on high energy protons by photographic emulsion method. D. LAL. *Proc. Indian Acad. Sci. A*, **37**, 93–9 (*July*, 1953).

An emulsion cloud chamber exposed for 6 hours at 90 000 ft was used to determine the flux of primaries of energy $E > 1{\cdot}6 \times 10^{12}$ eV. The energies of the primaries were estimated in two ways: (1) from the half angle of the cone containing the shower particles, and (2) from the growth of the soft component as a function of distance from the origin of the shower. The integral primary flux of protons ($E > 1{\cdot}6 \times 10^{12}$ eV) is found to be $0{\cdot}29 \pm 0{\cdot}07$ per m²/sec/steradian. This value fits the energy spectrum obtained by other workers. H. ELLIOT

537.591.1

2543. On the relation between the number of neutrons and protons and on some properties of the nucleonic components at 3500 m above sea level. M. CONVERSI, G. MARTELLI AND P. ROTHWELL. *Nuovo Cimento*, **10**, 898–914 (*July*, 1953) *In Italian.*

A fast, thin-walled ionization chamber, surrounded

with G.M. counters connected to a 22 channel-hodoscope, was used. The picture of each nuclear interaction taking place in the chamber and in which prongs were emitted which crossed the counters, was recorded by a typewriter triggered by the hodoscope. These "detectable prongs" are shown to correspond to the "grey tracks" and "shower particles" observed in photographic emulsions. Some results of the analysis of more than 13 000 stars are reported. (1) The ratio ρ of stars produced by neutrons to stars produced by protons is determined for stars with different numbers of detectable prongs. In particular it is found $\rho = 23 \pm 0{\cdot}4$ for stars with "no prongs" (which are shown to be produced by nucleons of average energy $E = 35$ MeV) while $\rho = 1{\cdot}53 \pm 0{\cdot}04$ for stars with at least one prong ($E > \sim 400$ MeV). (2) It is shown that the high value of ρ for stars of $\bar{E} = 35$ MeV cannot be interpreted only in terms of charge exchange and ionization losses undergone by protons through the atmosphere, but it is explained if the Coulomb barrier of the interacting nuclei is also considered. (3) The probabilities of producing a star with a given number of "backward" prongs are deduced for both neutrons and proton primaries. $\sim 30\%$ of stars with at least one "detectable prong" have at least one backward prong. (4) The zenith angle distribution of protons of $\bar{E} = 35$ MeV is found to fit a $\cos^{2{\cdot}8}$ law. (5) The differential distribution of stars with respect to the number of detectable prongs is given for both proton and neutron formed stars. (6) Good agreement is shown to exist between results and the phenomenological theories of the nucleonic component. A.

537.591.1

2544. Comparative study by means of sensitive emulsions of the properties of the nuclear component of the cosmic radiation near the equator. TSAI-CHÜ AND M. MORAND. *C.R. Acad. Sci.* [*Paris*] **237,** 1080–2 (*Nov.* 2, 1953) *In French.*

Observations on the intensity of slow protons at geomagnetic latitude 4° S and altitude 1600 m are compared with previous data for 25° N and altitude 1400 m. The E–W asymmetry is found to be less than that calculated. The zenith angle distribution, calculated by taking the mean in the east and west directions, appears to be independent of latitude.

H. ELLIOT

537.591.1 : 539.18

τ-meson investigation. *See Abstr.* 2754

537.591.15

2545. Production of penetrating showers in paraffin and lead. R. L. SEN GUPTA, K. K. ROY AND T. ROY. *Indian J. Phys.*, **27,** 191–6 (*April*, 1953).

Size-frequency distribution of penetrating showers generated in lead and paraffin at the sea-level were investigated by means of a counter-controlled cloud chamber. It was observed that the average multiplicity of penetrating showers and also their largest size are very closely the same in both the materials. From the results of observation it seems unlikely that the penetrating showers are generated in the nucleus in cascades (plural process) as suggested by Heitler and Janossy. The experimental results are more clearly understood on the basis of genuine multiplication of mesons, in which the particles are created in a single nucleon–nucleon collision. A.

537.591.15

2546. Some remarks on theoretical results of extensive air shower models. M. BRUIN. *Physica*, **19,** 909–14 (*Oct.*, 1953).

Data obtained from recent theoretical models of extensive air showers are discussed and a comparison is made with experimental values. Although several of the theoretical values disagree with experiment it appears quite possible to obtain consistency in most cases if small alterations are made. A.

537.591.2

2547. On the calculation of electron and photon tracks. R. CESTER AND E. CLEMENTEL. *Nuovo Cimento*, **10,** 1441–50 (*Oct.*, 1953) *In Italian.*

Starting from a solution of cascade theory given by a series of the kind used by Bhabha and Chakrabarty, the track length problem is solved both for electrons and photons. It is shown that it is possible to give a recurrence formula for the terms of the series. For $E = 0$ the series is indeterminate, but imposing to the integral electron track length to satisfy the energy conservation condition, the results are in good agreement with previous calculations. A.

537.591.5 : 519.283

2548. Chree analysis of pressure-temperature-corrected cosmic-ray burst frequencies. J. W. BROXON. *Nuovo Cimento*, **10,** 1434–40 (*Oct.*, 1953).

By Chree's method of superposed epochs, recurrence phenomena and relations to other variables had been found in the frequency of occurrence of small cosmic-ray bursts in a heavily shielded chamber at 1646 m altitude and 49° N geomagnetic latitude. The recurrences at intervals of about 27 days have been found to persist after correction of the burst data for variations in barometric pressure and atmospheric temperature by application of the very large coefficients, $-4{\cdot}58 \pm 0{\cdot}22\%$/mm Hg and $-2{\cdot}53 \pm 0{\cdot}10\%$/°C, determined recently. A defence of the Chree method of analysis is included. A.

537.591.8

2549. The spectrum of fast protons generated by the neutral component of cosmic radiation. A. DADAYAN AND G. MERZON. *Dokl. Akad. Nauk SSSR*, **86,** *No.* 2, 259–62 (1952) *In Russian.*

Using 5 trays of crossed "co-ordinate counters" in a magnetic field the momentum spectrum was measured for charged particles generated by neutral particles which entered a 9 cm Pb block without discharging shielding trays of counters. The difference spectrum of +ve (90%) and −ve (10%) particles follows closely a p^{-3} law for $p = 50$ to 500 MeV/c.

W. J. SWIATECKI

537.591.8

2550. On the production of fast deuterons in cosmic rays. A. A. ALIKHANYAN AND G. MARIKYAN. *Dokl. Akad. Nauk SSSR*, **87,** *No.* 2, 191–4 (1952) *In Russian.*

Using an arrangement similar to that of the preceding abstract with additional proportional counters and absorbers to select particles with ranges in several intervals, the mass spectrum of particles from a 9 cm Pb absorber was determined. In addition to a

peak in the 1700–2100 m_e region there is a resolved peak around 2700–4700 m_e. The deduced cross-sections for the production of deuterons in the 300–400 MeV range by more energetic neutrons has for Pb the high value of 0·2–0·3 geometrical.

W. J. SWIATECKI

537.591.8

2551. On the question of the generation of the electron-photon component by primary cosmic ray particles of various energies. S. I. BRIKKER, N. L. GRIGOROV, I. V. RŸBIN AND F. D. SAVIN. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 6, 1089–92 (1952) *In Russian.*

The particle flux and the ionization inside Pb shields of 0, 1, 2, 4 cm were measured as functions of height by alternate automatic insertion of a counter or ionization chamber inside the shield every 2 min during balloon flights up to 20 km. An analysis of results at latitudes of 31° and 51° shows that the primary proton flux in the range 1·5–7 BeV loses 230 ± 20 MeV/cm^2.sec^{-1} in generating the electron-photon component. It is also deduced that a primary of 20 BeV produces π-mesons in 3–4 cascades, and one of 3 BeV in 1–2 cascades.

W. J. SWIATECKI

537.591.8

2552. The spectra and sign distribution of particles from cosmic ray stars at 2860 metres altitude. C. C. DILWORTH AND S. J. GOLDSACK. *Nuovo Cimento*, **10**, 926–36 (*July*, 1953).

Measurements were made on mesons and protons emitted from stars recorded at 2860 m and compared with published results for balloon altitudes. It appears that, while the multiplicity of showers is greatly reduced at the lower altitudes, the normalized energy spectra are closely similar. The determination of the sign of the charge of particles leads to a preliminary determination of the positive-negative ratio of mesons produced at this altitude, and of πp's primary and secondary to stars. A.

537.591.8

2553. On the associated penetrating particles underground. C. CASTAGNOLI, A. GIGLI AND S. SCIUTI. *Nuovo Cimento*, **10**, 893–7 (*July*, 1953).

The cross-section for production of "associated penetrating particles" capable of penetrating at least 15 cm of Pb, by cosmic radiation at a depth underground of 50 m water equivalent, was studied with a counter hodoscope. The results confirm those previously reported, and they are briefly discussed and compared with recent ones by other authors. A.

537.591.8

2554. Altitude and geomagnetic effects of positive and negative penetrating particles of cosmic radiation. I. F. QUERCIA AND B. RISPOLI. *Nuovo Cimento*, **10**, 1142–71 (*Aug.*, 1953).

Experiments performed at various altitudes and at different zenithal and azimuthal angles are described. The aim of these experiments was to get information on meson production processes. Positive excess, E–W-asymmetry, N–S-asymmetry and zenithal distributions for different energies and at different altitudes were measured. All data collected have been compared with theoretical results of a plural production of mesons. Experimental results are not in disagreement with the theory. A.

537.591.8

2555. Production of neutrons of low energy from part of the cosmic radiation. M. GALLI. *Nuovo Cimento*, **10**, 1187–95 (*Aug.*, 1953) *In Italian.*

The theory of the scattering of neutrons in the atmosphere is treated in an elementary manner. In order to account for the 3·5 captures in air per sec per cm^2 at energies less than 0·4 eV calculated by Yuan [Abstr. 3605 (1951)] based on his experimental results and supposing that neutrons are all generated at 4 MeV, then the total number of generated neutrons must be 22 ± 4 per sec per cm^2. It results further that the number of neutrons generated at the height p (g cm^{-2}) must be $0{\cdot}218(\exp[-p/157] - 0{\cdot}8\exp[-p/70])$ per g per sec and 10% of the total number of generated neutrons. A.

537.591.8

2556. An analysis of "jets" initiated by high energy cosmic rays. C. C. DILWORTH, S. J. GOLDSACK, T. F. HOANG AND L. SCARSI. *Nuovo Cimento*, **10**, 1261–74 (*Sept.*, 1953).

A study was made of the variation of the multiplicity of jets with the energy of the primary, deduced from the angular distribution of the secondaries. The analysis has been made both on the hypothesis of pure multiple production, and following the model of Roesler and McCusker [Abstr. 7783 (1953)] of production in a "tunnel" through the nucleus. A.

MAGNETISM 538

538.07 : 536.483

Liquid helium cooled coils for making intense transient magnetic fields. *See Abstr.* 2372

538.081 : 538.311

2557. Concerning definitions of magnetic quantities. H. W. KATZ. Letter in *Amer. J. Phys.*, **21**, 647–8 (*Nov.*, 1953).

Gives a critical discussion of a paper by Hughes [Abstr. 2555 (1953)] on the interpretation of the magnetic vectors **B** and **H**. Katz believes that the use of the concept of magnetic dipoles is essential in defining these quantities, and that the use of the concept of "lines" of **B** or **H** may be fallacious. Other details of Hughes' paper are also criticized.

E. P. WOHLFARTH

538.081 : 538.311

2558. A discussion concerning "Definitions of magnetic quantities." J. V. HUGHES. Letter in *Amer. J. Phys.*, **21**, 648–9 (*Nov.*, 1953).

Author's reply to the criticism of his paper (preceding abstract). E. P. WOHLFARTH

538.081 : 621.3.081

2559. The c.g.s. units of magnetic susceptibility and specific magnetization. E. M. COHN AND M. MENTSER. *Amer. J. Phys.*, **21**, 681–2 (*Dec.* 1, 1953).

The units of susceptibility and magnetization can be chosen so that they are identical in the (unrationalized) 3- and 4-dimensional c.g.s. systems.

These units and the defining equations are given, and inconsistencies in the literature are pointed out. Adoption of the present definitions would eliminate much existing confusion and satisfy the various schools of thought. A.

538.082

2560. An apparatus for the accurate measurement of magnetic susceptibility. R. CINI AND L. SACCONI. *J. sci. Instrum.*, **31**, 56–9 (*Feb.*, 1954).

An apparatus is described for measuring the magnetic susceptibility of liquids and solutions by the Faraday method. The essential part is a quartz fibre vertical torsion balance. The accuracy of the measurements, which are made by a null method, is of the order of 1–2 parts in 10 000 with diamagnetics. A.

538.082.74

2561. New method of measurement of magnetic susceptibilities. A. PACAULT, B. LEMANCEAU AND J. JOUSSOT-DUBIEN. *C.R. Acad. Sci.* [*Paris*] **237**, 1156–8 (*Nov.* 9, 1953) *In French.*

An inductance apparatus for magnetic susceptibility determination is described. Values of χ obtained using this apparatus are in good agreement with recorded data. G. I. W. LLEWELYN

538.1

2562. Self-consistent spin-wave theory for the ferromagnetic exchange problem. M. R. SCHAFROTH. *Proc. Phys. Soc.* [*London*] *A*, **67**, 33–8 (*Jan.*, 1954).

A self-consistent improvement of Bloch's spin-wave treatment of the ferromagnetic exchange problem at low temperatures is developed. This leads to appreciable corrections to the spontaneous magnetization. A.

538.1 : 539.152.2

2563. Nuclear magnetism. E. M. PURCELL. *Amer. J. Phys.*, **22**, 1–8 (*Jan.*, 1954).

A review of modern developments in magnetism with special attention to the magnetic effects in gross matter that have their origins in the magnetic moments of nuclei. A.

538.113 : 537.12

2564. Effect of the surface on the magnetic properties of an electron gas. F. S. HAM. *Phys. Rev.*, **92**, 1113–19 (*Dec.* 1, 1953).

The energy levels of free electrons confined to a finite cylindrical box with a uniform axial magnetic field are obtained by the WKB approximation and used to compute the magnetic susceptibility with Fermi statistics. The usual treatments which neglect the effects of the walls are shown to be justified for both the steady susceptibility and the de Haas van Alphen terms provided the radius of the box is sufficiently large. In the case of the oscillatory terms it is only necessary that the radius of the box exceed the classical orbit radius R_c of an electron having the Fermi energy ζ in the magnetic field. However, there exists a surface correction to the steady susceptibility whose magnitude relative to the Landau value is $(\zeta/\beta H)^{\frac{1}{2}}(R_c/R)$. This surface correction, the existence of which has been previously pointed out by Osborne and Steele, and by Dingle, is shown to be extremely sensitive to the exact boundary conditions at the surface, including both the abruptness of the surface jump in potential and the height of the barrier relative to the Fermi energy. Indeed, the correction term can be either paramagnetic or diamagnetic depending on these details. The form of the WKB approximation appropriate to different boundary conditions is discussed, and a modification of Dingle's theory is presented which may be used to calculate approximately the susceptibility of the system for any value of the ratio R/R_c when the boundary conditions are known. A.

538.114

2565. On the spin wave theory of [the] Bloch wall. T. OGUCHI. *Progr. theor. Phys.*, **9**, 7–13 (*Jan.*, 1953).

An application of Anderson's extension of the spin wave treatment [Abstr. 5892 (1952)] to a determination of domain boundary widths in ferromagnetic media. Neglecting small terms the width is found to be proportional to $(J/K)^{\frac{1}{2}}$, where J is the exchange integral and K the anisotropy constant; this result agrees with that derived from the "classical" treatment. E. P. WOHLFARTH

538.114

2566. Verification of antiferromagnetism. F. BADER. Note in *Z. Naturforsch.*, **8a**, 498–9 (*Aug.*, 1953) *In German.*

A brief discussion purporting to explain the absence of typical antiferromagnetic behaviour in transition metals (Mn, Cr) and its presence in their oxides. Spin wave theory is taken to be applicable, but band theory is equally invoked. See also Abstr. 6934 (1953). E. P. WOHLFARTH

538.114

2567. Antiferromagnetism in metals. A. B. LIDIARD. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 1188–90 (*Dec.*, 1953).

An application of the collective electron treatment to transition metals apparently exhibiting antiferromagnetic behaviour, with special reference to chromium. The results of neutron diffraction, magnetic susceptibility and specific heat measurements are correlated. E. P. WOHLFARTH

538.114

2568. A review of new magnetic phenomena. R. E. ALLEY, JR. *Bell Syst. tech. J.*, **32**, 1155–72 (*Sept.*, 1953).

This paper reviews domain wall motion and dimensional effects in the low megacycle region, and ferromagnetic resonance and the Faraday effect in the microwave region and relates them to modern theory. Some possible microwave applications are discussed briefly. A.

538.114 : 539.11

Topics in the theory of the solid state. *See Abstr.* 2627

538.22

2569. The magnetic susceptibility of metallic uranium. L. F. BATES AND D. HUGHES. *Proc. Phys. Soc.* [*London*] *B*, **67**, 28–37 (*Jan.*, 1954).

The magnetic susceptibility of a pure specimen of metallic uranium was measured over the temperature range 15° to 920°C. It is proved that sudden changes in susceptibility accompany the α–β and β–γ phase

changes at 660°C and 767°C respectively. The results are compared with those of other workers, and the difficulties of providing an adequate explanation of the thermomagnetic behaviour are outlined. A.

538.22

2570. Intrinsic magnetization in platinum cobalt alloys. A. W. SIMPSON AND R. H. TREDGOLD. *Proc. Phys. Soc.* [*London*] *B*, **67**, 38–41 (*Jan.*, 1954).

A study of the effect of heat treatment on the intrinsic magnetization exhibited by alloys of platinum and cobalt containing small percentages of the latter material is described. The results are compared with those obtained from the platinum nickel series of alloys. Tentative conclusions concerning the nature of the exchange interaction in the two series of alloys are given. A.

538.22 : 536.48

2571. The de Haas–van Alphen effect in arsenic. T. G. BERLINCOURT. Letter in *Phys. Rev.*, **92**, 1068 (*Nov.* 15, 1953).

The de Haas–van Alphen effect was found in a crystal of As (~ 98·8% purity) at fields between 22 and 25 kG and temperatures of 4·2°K and below. The characteristic parameters were of the same order of magnitude as for Sn. D. SHOENBERG

538.22 : 536.63 : 539.11

Effects of band shape on the magnetic and thermal properties of metals and alloys. *See Abstr.* 2638

538.221

2572. Magnetisation curves for ferruginous manganese ores. B. S. R. RAO AND V. L. S. BHIMASANKARAN. Letter in *Curr. Sci.*, **22**, 300 (*Oct.*, 1953).

Summarizes results of measurements of I, H curves for ores containing differing amounts of Fe and Mn and having differing iron particle sizes. The coercive force was found to increase as the particle size decreases, the remanent magnetization to increase with increasing particle size and with increasing packing density. E. P. WOHLFARTH

538.221

2573. Theoretical interpretation of the antiferromagnetic resonance in copper chloride. J. UBBINK. *Physica*, **19**, 919–27 (*Oct.*, 1953).

A theoretical interpretation is given of the results on hydrated copper chloride, $CuCl_2.2H_2O$, using the theory of antiferromagnetic resonance at zero temperature [Abstr. 6937 (1953)], as well as the theory of Yosida [Abstr. 3423 (1953)]. With help of the former theory a satisfactory fit of the theoretical resonance fields in the co-ordinate planes of field space with the experimental resonance fields at the lowest temperatures is obtained using $H_c = c/\mu_x = 6{\cdot}56$ kOe, $H_b = b/\mu_x = 11{\cdot}71$ kOe and $H_a = a/\mu_x = 9{\cdot}71$ kOe, a, b, c and μ_x being quantities occurring in Gorter and Haantjes' theory of static antiferromagnetism. Using the theory of Yosida the absorption fields along the x-axis as functions of temperature are discussed. At temperatures above 2·4°K the higher absorption field coincides with the critical field strength H_c at which the spins flop over. Using an H_c, T-curve, determined by these values and by $H_c = 6{\cdot}56$ kOe at the lowest temperatures, and an α, T-curve ($\alpha = 1 - \chi_{\parallel}/\chi_{\perp}$) determined by susceptibility measurements, a satisfactory fit between theoretical and experimental values of the lower resonance field is obtained. Also an interpretation of the asymmetrical line shapes and the threshold absorption is found. A.

538.221

2574. Antiferromagnetic resonance in copper chloride. J. UBBINK, J. A. POULIS, H. J. GERRITSEN AND C. J. GORTER. *Physica*, **19**, 928–34 (*Oct.*, 1953).

A fuller account of absorption measurements at $9{\cdot}4 \times 10^3$ Mc/s, previously given in Abstr. 8314 (1952). When the x-, y- and z-axis of field space are chosen parallel to the a-, b- and c-axis of the crystal, the resonance fields in the xy-plane arrange themselves at the lowest temperatures on closed curves around the critical field on the x-axis at which the spins flop over. These curves expand when the temperature rises. In the xz-plane the resonance fields form hyperbola-like curves on both sides of the critical hyperbola at which the spin flops over, which move away one from another with increasing temperature. At temperatures near the Néel temperature asymmetrical line shapes are obtained. The intensity of the absorption shows a remarkable polarization effect. A.

538.221

2575. Ratio of exchange integrals in connection with angles between partial magnetizations in ferrimagnetic spinels. K. F. NIESSEN. *Physica*, **19**, 1035–45 (*Oct.*, 1953).

Allowing the spin direction of magnetic ions in one sublattice of (octahedral) B-sites to differ from that in the other sublattice of B-sites (as assumed by Yafet and Kittel for a spinel with only one kind of magnetic ions) a mixed crystal spinel containing two kinds of magnetic ions is considered, taking into account the different physical nature of the ions. Here a situation may be realized where the partial magnetizations are neither parallel nor antiparallel but where in one sublattice (say B_I) two special spin directions occur for the two kinds of magnetic ions and in the other (B_{II}) another couple of spin directions lying with the former set symmetrical with respect to the single spin direction of ions on the (tetrahedral) A-sites. The A-A interaction is neglected and consequently a subdivision of the A-lattice is not taken into account. Compositions of the mixed crystal are possible where such a non-rectilinear case is just possible, i.e. where the mutual deviations of the spin directions on the B-sites are very small, their angles with the spin direction on A-sites being nearly π. From three of such compositions the ratios of exchange integrals can be determined. A.

538.221

2576. On the magnetization of magnesium ferrite. N. SAKAMOTO, T. ASAHI AND S. MIYAHARA. Note in *J. Phys. Soc., Japan*, **8**, 677–8 (*Oct.*, 1953).

Describes measurements of the change of the magnetization of $MgO.Fe_2O_3$ as dependent on different degrees of previous heat treatment. The results are discussed on the basis of Néel's treatment of ferrimagnetism, the heat treatment being envisaged as causing a redistribution of the Mg^{++} ions among the two types of lattice site. E. P. WOHLFARTH

538.221 : 548.33

2577. Mechanism of transition in magnetite at low temperatures. H. J. Williams, R. M. Bozorth and M. Goertz. *Phys. Rev.*, **91**, 1107–15 (*Sept.* 1, 1953).

When magnetite is cooled through −160°c it is known to undergo a transition (cubic to orthorhombic) that is influenced by the presence of a magnetic field. The experiments described are in agreement with the following mechanism of the transition: The orthorhombic *c* axis is parallel to one of the original cubic axes and is the axis of easiest magnetization. Generally, different regions of the original crystal will transform with their *c* axis lying along different cubic axes, and when no field is applied there are 6 different orientations which different regions assume. When a field is applied during cooling a *c* axis tends to lie along the original cubic axis that is nearest to the applied field, the *a* and *b* axes having less but different tendencies to lie parallel to the field. Six magnetic crystal anisotropy constants are derived from torque curves measured in the (100) and (110) planes. From them magnetization curves are calculated for the [100] and [110] directions, and these are in agreement with experiment. A.

538.221 : 621.318.1

2578. Influence of small elastic strains on the initial susceptibility of some ferromagnetic substances. Ya. S. Shur and D. D. Mishin. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 543–7 (1952) *In Russian.*

Gives experimental curves for iron, nickel, 66-permalloy, 1% Si steel and two forms of transformer alloy for loads up to about 4 kg/mm^2. J. M. HOUGH

538.222

2579. The comparative influence of short and long range crystalline electric fields on the magnetic behaviour of the paramagnetic salts of the iron group of elements. I. A. Bose and S. C. Mitra. *Indian J. Phys.*, **26**, 393–426 (*Aug.*, 1952).

A critical discussion on the comparative influence of the various interactions, which arise in the solid or liquid states of the paramagnetic substances to cause the paramagnetic ions in them to deviate from the ideal gaseous behaviour is presented. In the magnetically dilute solid salts the only interaction of importance is the crystalline electric field due to the diamagnetic ions and dipoles surrounding the paramagnetic ion. This consists of (*a*) the direct action of the diamagnetic atoms immediately surrounding the paramagnetic ion, (*b*) the direct action of those atoms lying outside this cluster and (*c*) the indirect action of these distant atoms. Van Vleck has theoretically shown that though (*b*) is comparatively small, (*a*) and (*c*) are of comparable magnitudes. According to his theory there should be a large difference in the mean effective moment of these paramagnetic salts in the solid state and in solution as also an appreciable difference from salt to salt containing the same paramagnetic ion. In the iron group of salts, however, as is shown here, this effect is observed definitely only in the Co^{++} salts. It is probable that the room temperature values of the mean moments are not sufficiently sensitive to the action of the distant atoms. A.

538.222

2580. The comparative influence of short and long range crystalline electric fields on the magnetic behaviour of the paramagnetic salts of the iron group of elements. II. A. Bose and S. C. Mitra. *Indian J. Phys.*, **26**, 543–62 (*Nov.*, 1953).

In the first half of the iron group of elements between Ti^{+++} to Fe^{+++}, the orbital contributions to the magnetic moments are small or totally absent and the salts should approximately obey the Curie law. Effect of the long-range fields, therefore, would be difficult to detect. When, however, a close investigation is made it is found that the moment-temperature curves even for these ions deviate from salt to salt, and from the Curie law appreciably, indicating the action of long-range fields, as also the effect of the higher order terms usually neglected in discussions. The scope of the Jahn–Teller theorem, picturizing the inherent mechanism for removal of degeneracy of the paramagnetic ion, is discussed and extended to the whole of the crystal lattice. It is pointed out that when so extended the Jahn–Teller mechanism is identified with the entire crystalline field effect, and no extra mechanism is necessary to explain the effect of the distant atoms on the paramagnetic ion. A.

538.222

2581. The comparative influence of short and long range electric fields in the salts of the iron group of elements. III. A. Bose and S. C. Mitra. *Indian J. Phys.*, **27**, 95–108 (*Feb.*, 1953).

In Pt II [see preceding abstract] it was found that several instances of the existence of the effect of the long-range fields, in paramagnetic salts of the first half of the iron group of elements, arose, in spite of the conditions there being unfavourable for such observations. In the second half of the iron group the removal of orbital degeneracy by the cubic field in the first approximation, is less perfect. In consequence, Jahn–Teller distortions of the whole crystal lattice occur, giving rise to deviations from cubic field and hence further removal of the orbital degeneracy and to some extent the spin degeneracy. The spin-orbit coupling restores some of the orbital moment and at the same time causes a restraint on the orientations of the spins. These also lead to Jahn–Teller repercussions throughout the crystal lattice and to the final stabilization of the Stark-energy levels. It is thus seen that the final stabilization of the energy in the paramagnetic salts is dependent on the long-range fields, especially when removal of orbital degeneracy by the cubic field is imperfect. Clear evidence of this is found from the salts of the ions Fe^{++}, Co^{++} and to a smaller extent of Ni^{++}. Evidence from Cu^{++} salts is inconclusive for various reasons. A.

538.222

2582. Paramagnetic resonance of the double sulphate of manganese and ammonia. P. Brovetto, G. Cini and S. Ferroni. *Nuovo Cimento*, **10**, 1325–34 (*Sept.*, 1953) *In Italian.*

The properties of the paramagnetic salt $MnSO_4(NH_4)_2SO_4.6H_2O$ diluted with the corresponding Mg salt in the ratio roughly of Mn : Mg = 4 : 1000 were investigated by the resonance method, at room temperature. Fine and hyperfine structures

are satisfactorily resolved (2000 G for particular orientations of the crystal in the magnetic field). In these conditions the constants appearing in the Hamiltonian form of the problem have the following values: $D = 236$ G, $E = 44$ G, $A = -100$ G, $B = -104$ G. Having calculated the susceptibility with the usual statistical method, with terms containing D and E, results are compared with those obtained by Krishnan, Mookherji, Bose at the same temperature by means of classical measurements of susceptibility. A higher degree of precision is considered obtainable with the resonance method, consequently these values seem to be more reliable. A.

538.222

2583. Temperature change in the paramagnetic resonance spectrum of copper lanthanum nitrate. D. Bijl and A. C. Rose-Innes. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 954–6 (*Oct.*, 1953).

For $3Cu(NO_3)_2.2La(NO_3)_3.24H_2O$ diluted with the Mg salt the paramagnetic resonance changes gradually in the range 33–45°K from a low-temperature form with three Cu^{++} per unit cell with $g_{||} = 2{\cdot}45$, $g_{\perp} = 2{\cdot}10$ to a high-temperature form with one Cu^{++} per unit cell and isotropic with $g = 2{\cdot}23$.

D. H. WHIFFEN

538.222

2584. The anomalous paramagnetism of cupric acetate monohydrate. G. Foëx, T. Karantassis and N. Perakis. *C.R. Acad. Sci.* [*Paris*] **237**, 982–3 (*Oct.* 28, 1953) *In French.*

Describes susceptibility measurements on the salt $Cu(CH_3COO)_2.H_2O$ between 80° and 300°K. The susceptibility was found to have a broad maximum near 265°K. The results are discussed [cf. Abstr. 966, 967 (1953)]. For earlier measurements on the same salt, with which the present ones are compared, see Abstr. 5578 (1951). E. P. WOHLFARTH

538.222

2585. Magnetic behaviour of some ferrites. K. F. Niessen. *Physica*, **19**, 1127–32 (*Nov.*, 1953).

From the course of the Curie temperature of a series of mixed crystals of nickel ferrite and nickel titanate ($Fe_{2-2a}Ni_{1+a}Ti_aO_4$) with $0 < a < 0{\cdot}5$, measured as a function of the content a of titanium, by Gorter, the distribution of the titanium amongst the tetrahedral (A-) and octahedral (B-) sites of the spinel is derived on the assumption that nickel ions always occupy B-sites. The parameters necessary for this calculation were taken from the course of the Curie temperature of nickel zinc ferrite, measured as a function of the nickel content by Guillaud and Roux. The partial magnetizations in $Fe_{2-2a}Ni_{1+a}Ti_aO_4$ were taken parallel and antiparallel. In the case $a \ll 1$ the titanium appears to be distributed statistically (i.e. in the same ratio 1 : 2 as the numbers A- and B-sites), but at an increasing content of titanium this metal appears to have an increasing preference for the A-sites. A.

538.222

2586. Paramagnetic resonance absorption in graphite. J. G. Castle, Jr. Letter in *Phys. Rev.*, **92**, 1063 (*Nov.* 15, 1953).

Resonance lines at 9242 Mc/s were obtained for the free electrons in the two-dimensional plane in graphite with the magnetic field || and ⊥ to the oriented planes. Half-width at half-power 5–20 gauss.

D. H. WHIFFEN

538.222 : 539.166.9

2587. Paramagnetic resonances in irradiated glasses. E. L. Yasaitis and B. Smaller. Letter in *Phys. Rev.*, **92**, 1068 (*Nov.* 15, 1953).

Irradiation of glass with γ-radiation gives centres capable of detection by paramagnetic resonance at 100–375 Mc/s with $g \sim 2{\cdot}0$. The resonance amplitude varied linearly with optical density. D. H. WHIFFEN

538.224

2588. The magnetic susceptibility of germanium. D. K. Stevens and J. H. Crawford, Jr. Letter in *Phys. Rev.*, **92**, 1065 (*Nov.* 15, 1953).

Measurements of the diamagnetic susceptibility of single crystals of Ge containing different impurity concentrations suggest that the contribution due to the Ge atoms is temperature-dependent and that the orbital diamagnetism of the free carriers exceeds the paramagnetism of the free carriers and impurities in both electron and hole conductors. A. E. DE BARR

538.23 : 538.65 : 621.318.134.013

2589. Stressed ferrites having rectangular hysteresis loops. H. J. Williams, R. C. Sherwood, M. Goertz and F. J. Schnettler. *Commun. and Electronics*, *No.* 9, 531–7 (*Nov.*, 1953).

A study has been made of the effect of stress on the magnetic properties of ferrites. Rectangular hysteresis loops were obtained by encasing toroidal specimens in plastics which shrink during polymerization. Ferrites having this type of hysteresis loop are useful in magnetic switching and magnetic memory devices. A.

538.245

2590. Magnetization in nickel ferrite-aluminates and nickel ferrite-gallates. L. R. Maxwell and S. J. Pickart. *Phys. Rev.*, **92**, 1120–6 (*Dec.* 1, 1953).

Trivalent aluminium and trivalent gallium have been substituted for trivalent iron in nickel ferrite $NiO.Fe_2O_3$ to give the systems $NiO.Fe_{2-t}Al_tO_3$ and $NiO.Fe_{2-t}Ga_tO_3$, respectively, where t goes from 0 to 2. The materials, annealed and prepared in a powdered form, were homogeneous with the length of the edge of the unit cell decreasing linearly from 8·332 Å to 8·043 Å and 8·247 Å, for the aluminium and gallium substitution, respectively, as t varies from 0 to 2. In the case of the aluminium substitution, thermomagnetic curves were obtained of the types classified by Néel as Q; M_1, M_2 or P; and type R. The saturation magnetization extrapolated to 0°K (μ_0) for the nickel ferrite-aluminates decreases linearly with increase in t approaching zero in the region of $t = 0{\cdot}63$; for further increase in t, μ_0 increases to a maximum at about $t = 1{\cdot}0$ beyond which it decreases again to 0 at $t = 2$. The increase in μ_0 is interpreted as an indication of a reversal in the direction of the resultant magnetization due to predominance of the magnetization of the ions on the A sites over those on the B sites. For the gallium substitution, the thermomagnetic curves follow the more conventional Q type with the appearance of the R-type curves for values of t from 0·63 to 1·5. As contrasted to the aluminates, the gallates show an increase in μ_0 with t, with a maximum developing in approximately the

same region where the aluminates showed the cross-over from *B* dominance to *A* dominance. The Curie temperatures decrease near-linearly with increase in t; the points for the aluminates and the gallates are so close together that they can be represented by one smooth curve. From an application of the Néel theory, it is indicated that the *BB* interaction is negative, both for the aluminates and the gallates, at least for values of t in the region 0·63 to 1·00. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 530.12

On the electromagnetic potentials in Einstein's unified theory. *See Abstr.* 1997

538.3 : 537.12 : 530.162

2591. On the statistical mechanics of matter in an electromagnetic field. I. Derivation of the Maxwell equations from electron theory. P. MAZUR AND B. R. A. NIJBOER. *Physica*, **19**, 971–86 (*Oct.*, 1953).

Maxwell's macroscopic field equations are derived from the fundamental microscopic equations of electron theory in a new way. Instead of the usual space-time averaging procedure a statistical ensemble averaging method is applied, which is perhaps more satisfactory both from a physical and from a mathematical point of view. The treatment is valid for multicomponent systems, in which every component may move in an arbitrary way, so that, e.g., diffusion phenomena are included. Furthermore, it would seem that the method given here is also suitable for the discussion of other problems connected with the behaviour of matter in an electromagnetic field. A.

538.551 : 621.372

2592. General network analysis. W. R. LEPAGE AND S. SEELY. *New York: McGraw-Hill* (1952) vii + 516 *pp.*

"A general introduction to network analysis and network synthesis which covers steady-state lumped and distributed networks and transients in lumped networks."

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

2593. On reciprocity theorems in electromagnetic theory. T. H. CROWLEY. *J. appl. Phys.*, **25**, 119–21 (*Jan.*, 1954).

Various forms of the reciprocity theorem arise in electromagnetic theory because of differences in the source of the fields. Five different types of sources are discussed briefly and the corresponding reciprocity theorem given. A.

538.565 : 621.372.413 : 621.317.39

2594. A simple bridge method of measurement of the time constant of exponential decays. C. M. BURRELL. Note in *Brit. J. appl. Phys.*, **4**, 350 (*Nov.*, 1953).

The decrement of a high Q-factor cavity resonator at 3000 Mc/s is measured by exciting it with a relatively long pulse at its resonant frequency. The output is rectified, amplified and fed to the RC network devised, when under given conditions the output from the circuit will be zero during the decay of the free oscillations in the resonator. From R and C the decrement can be calculated. E. H. W. BANNER

538.566 : 621.372.2

2595. On a property of a family of equiangular spirals and its application to some problems of wave propagation. K. LANDECKER. *J. appl. Phys.*, **25**, 41–8 (*Jan.*, 1954).

It is shown that all the normals drawn from any point in the plane to the members of a family of equiangular spirals may be simply located geometrically. The locus of all the end points of the normals is a circle. It is also shown that the standing wave pattern in a uniformly attenuating medium may in simple cases (as with an attenuating transmission line) be represented by a vector diagram using a symmetrical pair of spirals. Then the above theorem makes it possible to determine the voltage and current maxima and minima by constructing the locus circle referred to. This is illustrated by several examples. Finally it is pointed out that the locus circle may also be projected into the "Smith Chart." A.

538.566.2 : 534.62

A new large anechoic room for sound waves and short electromagnetic waves. *See Abstr.* 2189

538.566

2596. Diffraction of microwaves by apertures and obstacles. S. SILVER. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 401–8 (1952).

A periodic fluctuation of E_{tang} in an aperture in a conducting plane is found experimentally up to diameters of 35λ, whereas H_{tang} is constant over the aperture. The electromagnetic Babinet principle is verified for complementary obstacles. D. H. WHIFFEN

538.566

2597. Some recent developments in microwave diffraction. F. J. ZUCKER. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 442–9 (1952).

A review of experimental and theoretical work with a comparison of the types of approximations applied in various parts of the range from optical to static waves. D. H. WHIFFEN

538.566

2598. Diffraction of 3 cm waves by cylinders of the same diameter as the wavelength. KRISHNAJI AND P. SWARUP. Letter in *J. sci. industr. Res.*, **12B**, 331 (*July*, 1953).

Preliminary results of an investigation of the diffraction of 3 cm waves by cylinders of brass and sulphur whose diameters were of the order of the wavelength. Curves of E- and H-plane field strength at a distance of 250 cm are given. G. D. SIMS

538.566

2599. Microwave diffraction measurements in a parallel-plate region. R. V. ROW. *J. appl. Phys.*, **24**, 1448–52 (*Dec.*, 1953).

Many infinite two-dimensional electromagnetic-scattering problems are strictly equivalent to the configuration obtained from the image principle by placing a finite-scattering obstacle between two

parallel, infinite and perfectly conducting planes and illuminating it with a plane or cylindrical incident wave confined to the parallel-plate region. An experimental approximation to this arrangement is described for use in the 3 cm wavelength region. Finite rectangular parallel metal plates support a transverse incident electromagnetic wave with the electric field oriented perpendicular to the plates. Absorbing wedges at the boundary of the region reduce reflections from this discontinuity. The electromagnetic field scattered from any particular obstacle may be investigated by means of a dipole probe introduced into the region through a movable section of one of the plates. The success of this technique is demonstrated by comparing measurements of the total field scattered by infinite conducting wedges of included angle 0, 45 and 90 degrees with the known theoretical expressions, for perpendicular incidence. Agreement with theory is good. The effect of finite thickness of the diffracting screen (case of 0° wedge) in increasing the amplitude of the scattered wave is noted and compared to theoretical results derived for scattering from a thin conducting half-plane with a cylinder superimposed on the edge. A.

538.566

2600. The diffraction of waves in passing through an irregular refracting medium. J. A. Fejer. *Proc. Roy. Soc. A*, **220**, 455–71 (*Dec.* 22, 1953).

A relation is derived between the angular power spectrum of waves emerging from a thin diffracting screen random in two dimensions and the auto-correlation function describing the irregularities of the field as it emerges from the diffracting screen. The special case of an isotropic screen characterized by an auto-correlation function which depends only on distance and not on direction is discussed for normal and oblique incidence. Multiple scattering of waves caused by volume irregularities of the dielectric constant is considered. The angular power spectrum and the auto-correlation function describing the irregularities of the diffraction field caused by multiple scattering in a thick slab are determined. The results are compared with those obtained by Hewish [Abstr. 9621 (1951)] for a thin phase-changing screen. The results are discussed in terms of problems arising in the study of radio-wave propagation. A.

538.566 : 535.22

2601. The measurement of the velocity of electromagnetic waves and the refractive index of air at microwave frequencies. L. Essen and K. D. Froome. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 277–82 (1952).

From microwave resonance cavity measurements are obtained accurate values for the refractive indices of air, O_2, N_2, A, CO_2 and H_2O vapour as a function of temperature. These are combined with free space interferometric measurements at 24 005 Mc/s to give $c = 299\,792{\cdot}6 \pm 0{\cdot}7$ km/sec which is compared with other recent determinations. D. H. WHIFFEN

538.566 : 535.4

2602. Experimental demonstration on the microwaves and their optical analogs. G. F. Hull, Jr. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 288–303 (1952).

An account of demonstration experiments with lenses, prisms, polarized light, etc., showing diffraction, reflection interference, etc., at 3 cm wavelength. D. H. WHIFFEN

538.566 : 535.417

2603. Filter action of parallel wire grids. E. A. Lewis and J. P. Casey. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 336–9 (1952).

A grating with fine wires || to the E vector may replace the reflecting films in a Fabry–Perot type interferometer to give much increased transmission maxima for the same spacing and bandwidth. Experiments at 1·25 cm are in qualitative agreement. D. H. WHIFFEN

538.566 : 535.42 : 534.26

2604. Methods of light optics for the calculation of the diffraction phenomena within the range of centimeter waves. H. Severin. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 381–400 (1952).

Kirchhoff's equations from light optics and the corresponding vectorial equations are used to calculate the approximate fields in apertures in infinite conducting sheets and near conducting disks. The results are compared with experiment. The plausible boundary conditions are discussed and $H_{tang} = 0$ on the screen is best for the aperture while $E_{tang} = 0$ on the disk is preferable. A reflection coefficient is introduced for the case of dielectric disks. The approximations are effective even near the disturbance. The analogous approach for sound waves is discussed in the appendix. D. H. WHIFFEN

538.566 : 535.5

2605. Polarimetry in the region of Hertzian waves. A. Kastler. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 315–21 (1952) *In French.*

A review of the principles and microwave applications of natural and artificial birefringence and magnetic rotatory polarization or Faraday effect. D. H. WHIFFEN

538.566 : 536.7

2606. On the thermodynamics of electromagnetic waves. T. Kahan. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 304–14 (1952) *In French.*

The microwave analogues of arguments by Jeans, von Laue and Landé for the optical region, lead to expressions for the number of independent degrees of freedom required to describe a pencil of rays of finite duration and bandwidth and also the degrees of freedom required for rays falling on a finite area from a finite solid angle at any instant. The entropy and equivalent temperature of radiation are discussed in relation to coherence. It is shown that diffraction at a grating of infinite extent occurs without change of entropy and is reversible. D. H. WHIFFEN

538.566 : 538.61

2607. The Zeeman and magneto-optical effects in the microwave region. R. Malvano. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 340–53 (1952).

A review of paramagnetic and ferromagnetic resonance, the Zeeman and Faraday effects and magnetic double refraction, all at microwave frequencies. Optical detection of transitions induced by microwaves is also discussed. D. H. WHIFFEN

538.566 : 621.396.11

2608. The reflection of electromagnetic waves from a rough surface. H. DAVIES. *Instn Elect. Engrs Monogr. No.* 90, 6 *pp.* (*Jan.* 15, 1953) [To be republished in *Proc. Instn Elect. Engrs IV*].

The scattering and reflecting properties of surfaces which are perfectly conducting but which have random irregularities are investigated statistically. The surface is assumed to be not too precipitous. With a statistical model for the surface, the scattering of light by a disturbed water surface is considered, and the method is used to calculate the amount of sea clutter observed in centimetric radar. A comparison with some observations is made. A.

538.566

2609. The radiation at a great distance from the open end of Lecher cylinders or of a single tube. H. FLORIAN. *Acta phys. Austriaca*, **8**, *No.* 1, 42–62 (1953) *In German.*

Such problems are of technical importance but their exact treatment is mathematically cumbersome. Approximate treatments have therefore been devised, and the present is, in part, an extension of the work of Schelkunoff [*Bell Syst. tech. J.*, **15**, 92–112 (*Jan.*, 1936)]. Formulae of simple type are obtained and compared with earlier results. P. M. DAVIDSON

538.566 : 621.372.8

2610. Reflection of electromagnetic waves by non-homogeneous bounding surfaces with a periodic structure perpendicular to the *E*-vector. R. MÜLLER. *Arch. elekt. Übertragung*, **7**, 492–500 (*Oct.*, 1953) *In German.*

A thorough mathematical analysis is made of the solutions of the wave equation, which are relevant in certain problems involving rectangular waveguides. The cases treated include (1) a change in the cross-section, and (2) effect of a diaphragm. Explicit expressions are found for the components of the electric and magnetic fields. L. S. GODDARD

538.566

2611. Applications of differential geometry to microwave optics. K. S. KUNZ. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 322–32 (1952) *In French.*

The problem is discussed of the equivalence as regards optical pathlength between a flat disk of variable refractive index and a three-dimensional mound-shaped surface and especially the surface of constant refractive index. The analogue of the flat Luneberg lens, such that a point source on its circumference gives rise to a parallel beam, was constructed in parallel plates. At 3 cm the observed beam width was only 3° and the first lateral lobe was 22 db lower in power. D. H. WHIFFEN

538.566 : 621.396.67

2612. The effect of aperture errors on the antenna radiation pattern. J. RUZE. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 364–80 (1952).

The theory of random errors in microwave aerials is developed and the worsening of performance observed at 3·2 cm with a parabolic reflector intentionally distorted is in agreement. D. H. WHIFFEN

538.566.2 : 621.396.96

2613. Interpretation of the fluctuating echo from randomly distributed scatterers. I. J. S. MARSHALL AND W. HITSCHFELD. *Canad. J. Phys.*, **31**, 962–94 (*Sept.*, 1953).

The radar echo from randomly distributed scatterers fluctuates in intensity about a mean equal to the sum of the intensities contributed by each particle. If k independent intensity values are averaged, the r.m.s. deviation of the fluctuation is reduced by a factor $\sqrt{k}$. Counting the fraction of signals falling above one or more thresholds is a practically simpler, though somewhat less rapid, alternative to averaging. As a further alternative, many independent sweeps of amplitude or signal level can be superimposed on an A-scope, and so observe the most probable value. In range interval l, a single sweep contains $2l/h$ independent data, where h is the pulse length. The intensity averaged under the continuous trace is slightly more accurate than the average of the independent data. Pulses sent through the same scatterers yield identical returns until the scatterers have had time to reshuffle themselves. Successive pulses give independent echoes, however, if their frequencies differ by about $1/\tau$, τ being the pulse duration. Echoes from the same pulse received at separate aerials are similarly independent. Several (k) independent echo values are helpful in measuring steady echoes against a noise background. For fluctuating echoes, k must be large, regardless of the relative strengths of echo and background. Large values of k in addition materially enhance the detectability of fluctuating echoes weak compared to the noise. A.

538.566.2 : 621.396.96

2614. Interpretation of the fluctuating echo from randomly distributed scatterers. II. P. R. WALLACE. *Canad. J. Phys.*, **31**, 995–1009 (*Sept.*, 1953).

The determination of the probability distribution for the magnitude of a radar echo from randomly distributed scatterers is a standard problem of the "random walk" type. The information obtained on the scatterers from observation of the echoes is discussed, and also the methods for extending it. The method of averaging independent signals is investigated, and compared with the method of continuous averaging, which is found to be somewhat better. By appropriate variation of frequency of the radiation, it is found possible to obtain effectively independent determinations from a given region. The continuous variation of signal with time is studied, and a simple picture of the development of the signal proposed. The Markoff method is used throughout. A.

538.566.3

2615. Studies on ionospheric absorption. B. CHATTERJEE. *Indian J. Phys.*, **26**, 585–96 (*Dec.*, 1952).

This discusses briefly the phenomenon of ionospheric absorption of radio waves in their passage through the ionospheric regions. Results of observations made at Calcutta on the variation of ionospheric absorption with that of wave frequency are described. The results show that in addition to the losses due to collisions there is a marked increase in attenuation near the critical frequencies of the layers due to partial penetration of the wave energy. Presence of sporadic

E-layers also causes increased attenuation of *F* echoes by partial reflection and scattering. When there is magneto-ionic splitting, the extraordinary component is always found to suffer higher attenuation as predicted by theory. On certain nights presence of sporadic *D*'s was noticed. This caused high absorption on all frequencies in the short-wave range. The sporadic *D*'s are found to be associated with sporadic *E* and thunderstorms. A.

538.566.3 : 550.38 : 551.510.535

2616. On a new phenomenon of interaction between a wave and free electrons superposed on the terrestrial magnetic field. M. CUTOLO. *Nuovo Cimento*, **9**, 687–98 (*Aug.*, 1952) *In Italian.*

A new phenomenon of "self-interaction" in radio propagation has been observed, in which a wave shows a marked decrease in its modulation percentage after passage in the ionosphere when its frequency is near the local gyro-frequency. Typical reduction is from 80% to 40% modulation at 1·2 Mc/s. This is important in studies of the *E*-layer, and some consideration of the physical process of the phenomenon is given. G. M. BROWN

538.566.3 : 550.38 : 551.510.535

2617. Measurements of the terrestrial magnetic field in the *E*-layer. M. CUTOLO. Letter in *Nature* [*London*] **172**, 774–5 (*Oct.* 24, 1953).

Precise measurements are possible using the phenomena of gyro-interaction [Abstr. 8890 (1950)] and self-demodulation [preceding abstract]. Some results are given, all of which show that *H* in the *E*-layer is somewhat less than its ground-level value.

G. M. BROWN

538.566.3 : 621.396.11

2618. Prediction of ionospheric propagation for distances greater than 10 000 km. E. HARNISCHMACHER. *C.R. Acad. Sci.* [*Paris*] **237**, 1071–3 (*Nov.* 2, 1953) *In French.*

A new method of calculation of max. and min. usable frequencies has been developed which is the logical development of the author's analytical method already used. The chief feature of the method is the allowance for mixed multiple reflections of the type $mF + nE$. G. M. BROWN

538.569 : 535.214 : 534.39

Radiation pressure against perfect reflectors. *See Abstr.* 2175

538.569.3

2619. Absorption of millimeter waves in dielectric solids. W. L. BROOKS, J. H. GREIG, C. PINE, W. G. ZOELLNER AND J. H. ROHRBAUGH. *J. Opt. Soc. Amer.*, **43**, 1191–4 (*Dec.*, 1953).

Harmonics of the 3J31 magnetron (12·5 mm fundamental wavelength), dispersed by an echelette grating, were used to measure the complex index of refraction for polystyrene, for Plexiglass and for high melting paraffin. Data having ¼% uncertainty are given for the region $\lambda 4 \cdot 2$ mm to $\lambda 1 \cdot 8$ mm, no dispersion being observed. The indices are calculated from phase angle and transmission intensity measurements which are applied to a suitable boundary value equation by means of an iteration process. A.

MAGNETIC EFFECTS 538.6

538.63 : 537.311.33

On the electrical properties of InSb. *See Abstr.* 2431

538.652

2620. Some magnetostriction relations in materials possessing preferred domain orientations. G. T. RADO. *J. appl. Phys.*, **25**, 102–6 (*Jan.*, 1954).

Simple relations between certain magnetostrictive strains are derived for polycrystalline ferromagnetic materials possessing a preferred axis in the distribution of domain orientations. Good agreement with experimental results is obtained. A.

538.652 : 621.317.4

2621. A method of measuring magnetostriction. A. W. COCHARDT. *J. appl. Phys.*, **25**, 91–6 (*Jan.*, 1954).

Torsion tests are made on wires of various ferromagnetic materials. It is found that the relationship between shear stress and shear strain is different for magnetized and unmagnetized wires. The difference is explained in terms of wall movement and rotation of ferromagnetic domains, and magnetostriction values are derived from it. This method of determining magnetostriction has several advantages. It is simpler to carry out than most other methods, its accuracy is 4×10^{-7}, and it can be used at elevated temperatures. Its main limitation is that saturation magnetostriction values are not obtainable for alloys which have a large crystal anisotropy energy. A.

538.653.16

2622. The variation of the magnetic permeability of soft steel under the influence of an alternating force. G. VIDAL AND P. LANUSSE. *C.R. Acad. Sci.* [*Paris*] **237**, 1213–15 (*Nov.* 16, 1953) *In French.*

Describes experiments on a cylindrical test piece of 0·12C steel. The induced e.m.f. in a secondary coil surrounding the specimen due to the change of the magnetic permeability on applying to it a periodic force was examined on a c.r.o. The results are compared with related ones obtained by Langevin [Abstr. 2878, 7142 (1951)]. E. P. WOHLFARTH

538.67 : 537.523

2623. Production of magnetic fields in liquid mercury by mechanical motion. F. BURHORN, H. GRIEM AND W. LOCHTE-HOLTGREVEN. Letter in *Nature* [*London*] **172**, 1053–4 (*Dec.* 5, 1953).

Describes experiments the results of which had been summarized previously [Abstr. 8429 (1953)].

E. P. WOHLFARTH

538.67 : 537.523

2624. Magnetic fields measured within flames brought mechanically into rotational motion. P. SCHILLING AND W. LOCHTE-HOLTGREVEN. Letter in *Nature* [*London*] **172**, 1054 (*Dec.* 5, 1953).

Describes experiments the results of which had been summarized previously [Abstr. 8428 (1953)].

E. P. WOHLFARTH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

2625. Recent researches in the theory of solids. N. F. MOTT. *Nuovo Cimento*, **10**, *Suppl. No.* 3, 211–24 (1953) *In Italian.*

Reviews work on solids since 1928 and in particular since 1948. The subjects treated include: electron spin and magnetic properties, Skinner's soft X-ray work, free-electron contributions to X-ray absorption by metals, the theory of defects in crystalline solids, edge and screw dislocations and observations of spiral growth. [Contains a detailed bibliography of papers on theory of crystal growth.] C. A. HOGARTH

539.11 : 548.7

2626. Introduction to solid state physics. C. KITTELL. *London: Chapman and Hall*, 396 *pp.*

Review in *Phil. Mag.*, **45**, 109 (*Jan.*, 1954). "Deals with crystal structure, lattice energies and thermal capacities; 110 pages follow on dielectric and magnetic properties of crystals; 100 on electrical properties; 50 on imperfections in solids, including firstly Frenkel defects and related topics, and secondly dislocations and mechanical properties. Finally, there are 50 pages of Appendices elaborating some of the more mathematical points."

539.11 : 538.114

2627. Topics in the theory of the solid state. E. W. MONTROLL AND OTHERS. *Institute for Fluid Dynamics and Applied Mathematics, University of Maryland: Lecture Series No.* 27. 2 *vols.*, 144 *pp.* (1953) *Mimeographed typescript.*

A course of post-graduate lectures reviewing the mathematical theory of the following topics: characterization of solids, properties of ionic lattices, specific heats of solids, elastic constants of cubic crystals and their normal vibrations, fundamental electron theory of solids, zone theory, theory and applications of Wannier functions, Weiss theory of ferromagnetism, Hamiltonian operator for a ferromagnet, Heisenberg theory of ferromagnetism, spin wave theory of ferromagnetism, ferromagnetic domains, lattice defects, semiconductors, optical properties of semiconductors, theory of co-operative phenomena and phase transitions. References for further reading are given. E. H. SONDHEIMER

539.11

2628. The theory of metals. A. H. WILSON. 2nd Ed. *Cambridge: University Press*, 346 *pp.*

Review in *Phil. Mag.*, **45**, 108 (*Jan.*, 1954). "The optical properties of metals are not discussed in the second edition and superconductivity is also left out. This is in line with the apparent intention of the author, not to touch upon subjects of which the present theory is still highly unsatisfactory."

539.11

2629. Dependence of the characteristic frequency of a solid on temperature and volume, according to statistical mechanics. P. G. BORDONI. *Nuovo Cimento*, **10**, 268–80 (*March*, 1953) *In Italian.*

The Grüneisen coefficient $\gamma_T = -(\partial \log \nu/\partial \log V)_T$ is derived from the equation of state of solids in terms of the analogous coefficient $-(\partial \log \nu/\partial \log V)_P$, where ν is frequency. Above the Debye temperature the formulae reduce to simpler forms. Good agreement is obtained when the derived equations are compared with experimental data. C. A. HOGARTH

539.11

2630. Deduction of an equation of state for solids from the theory of finite thermoelastic transformations. P. G. BORDONI. *R.C. Accad. Naz. Lincei*, **14**, 784–90 (*June*, 1953) *In Italian.*

The stress P is assumed to be constant over the whole solid, and the temperature uniform: thus P depends only on V and T an an equation of state can be derived as a series of powers of the change of volume, the coefficients being expressed in terms of the expansion coefficient and of Lamé's constants. The value of the isothermal compressibility deduced from this equation agrees with that given by usual theory; the change of pressure with temperature at constant volume agrees with that given by the statistical theory of solids. A very simple expression is obtained for Grüneisen's coefficient, in fair agreement with experiment for solids in which the ratio of the two Lamé's constants does not differ much from unity. L. PINCHERLE

539.11 : 548.7

Transition between homopolar and ionic binding in crystals. *See Abstr.* 2856

539.11

2631. A calculation of the eigenvalues of electronic states in metallic lithium by the cellular method. B. SCHIFF. *Proc. Phys. Soc.* [*London*] *A*, **67**, 2–8 (*Jan.*, 1954).

A potential function is computed for the lithium ion core, and is used to calculate the cohesive energy of metallic lithium, which is found to be in good agreement with experiment. Eigenvalues for conduction electrons in metallic lithium are calculated for points of high symmetry in the Brillouin zone, using the improved cellular method of Howarth and Jones [Abstr. 5218 (1952)], in which boundary conditions are applied at a large number of points on the surface of the atomic polyhedron; the merits of this type of boundary condition are discussed. The energy gap at the centre of a face of the zone is found to be 2·57 eV, the lowest state at that point having a *p*-like symmetry, and the interpretation of the soft X-ray emission spectrum of lithium is discussed in the light of this result. A.

539.11 : 548.7

2632. Electronic eigenvalues of copper. D. J. HOWARTH. *Proc. Roy. Soc. A*, **220**, 513–29 (*Dec.* 22, 1953).

The cellular method as developed by Howarth and Jones [Abstr. 5218 (1952)] is applied to the face-centred cubic crystal, and, in particular, the eigenvalues and wave functions of the 3*d* and 4*s* electrons in metallic copper are obtained for states whose wave vectors lie at the ends of the three- and four-fold axes in the Brillouin zone. The conduction electrons approximate closely to free electrons inside the first Brillouin zone, but the energy gaps at the zone faces are found to be sensitively dependent upon the

potential used to represent the copper ion. The eigenvalues of the 3*d* band agree closely with Fletcher's results for nickel, and show a band width of 3·46 eV. An approximate solution of the Hartree equations for the metal shows the top of the *d*-band to lie 3·7 eV below the Fermi level in the conduction band. A.

539.11

2633. Momentum distribution of electrons in solids: results for some metals using the Thomas–Fermi method. N. H. MARCH. *Proc. Phys. Soc.* [*London*] *A*, **67**, 9–16 (*Jan.*, 1954).

Experimental results giving the shape of the Compton profile in X-ray scattering show that the momentum distribution of the electrons in metallic Li and Be differs markedly from that given by wave-mechanical calculations for isolated atoms. As the starting point of a detailed theoretical investigation the present paper is concerned with examining the momentum distribution of electrons in metals on the basis of the Thomas–Fermi theory. Quantitative results are presented for Li, Be, Na, K and Rb, and a considerable broadening of the Compton line due to the interaction of atoms in a lattice is unmistakably shown. Agreement with experiment is, however, poor for Li, and it is concluded that the momentum distribution of the valence electrons in metallic Li differs considerably from a free electron distribution. For Be there is surprisingly good agreement with experiment, but unfortunately no experimental results exist as yet for the other metals. The effect of introducing exchange is examined in detail for Na and some additional broadening of the Compton line is found. Finally, the concept of free electrons in the Thomas–Fermi theory is discussed. A.

539.11

2634. Electronic [energy] states of cubic crystals in Brillouin's approximation. J. HOMILIUS. *Z. Naturforsch.*, **8a**, 432–41 (*July*, 1953) *In German.*

An application of the nearly free electron approximation, particularly to the face-centred cubic crystal. The energy is calculated at and near symmetry points and along certain lines in the first Brillouin zone. The Fourier coefficients of the potential energy are taken to be parameters to which special values are assigned for illustrative purposes. Energy gap values are also calculated for representative cases in terms of the Fourier coefficients. E. P. WOHLFARTH

539.11 : 538.632

2635. Brillouin zone investigation of Mg alloys. I. Hall effect and conductivity. A. I. SCHINDLER AND E. I. SALKOVITZ. *Phys. Rev.*, **91**, 1320–2 (*Sept.* 15, 1953).

The Brillouin zone structure of hexagonal metal, in particular magnesium as calculated by Jones, was examined by Hall measurements. The theory predicts a strong dependence on alloying, and the Hall data obtained on alloys of magnesium with aluminium or silver seem to corroborate Jones's theory. In the case of the silver alloys, the absolute value of the Hall constant decreases linearly as a function of alloying addition (0·1 at. % silver decreases the Hall constant by 5%). In the aluminium alloys the effect is not so great (0·1 at. % aluminium decreases the Hall constant by ~2%) and a break in the Hall constant *v.* composition curve is detected. This break can be interpreted as being due to Brillouin zone overlap in the *c* direction. Familiar conductivity rules for alloys are examined in the light of Jones's theory and it is shown that deviations from these rules are to be expected for the alloys of divalent hexagonal metals. A broad experimental programme is outlined. A.

539.11

2636. Exchange potential in the surface region of a free-electron metal. H. J. JURETSCHKE. *Phys. Rev.*, **92**, 1140–4 (*Dec.* 1, 1953).

The weighted average exchange charge and the average exchange potential proposed by Slater have been evaluated explicitly in the surface region of a free-electron gas bounded by an infinite barrier. It is found that in the surface the exchange hole ceases to accompany its electron and that the exchange potential beyond the surface is essentially that due to an exchange hole stationary in the surface region. This interpretation explains the failure of the statistical approximation to the exchange potential at low electron densities. At high densities, the statistical approximation agrees closely with the average exchange potential. In the surface region the normally spherically symmetrical exchange hole becomes distorted. This change of shape is discussed qualitatively for electrons in the immediate surface region and electrons very far from the surface of a distribution bounded by a finite low barrier. The exchange surface energy of this model of a metal surface is 96 ergs/cm^2 for an interior density equal to that of sodium. A.

539.11 : 537.311.31 : 536.212.2 : 537.32

2637. Changes in the electrical, thermal, and thermoelectrical properties of monovalent metals by lattice distortions. A. W. SÁENZ. *Phys. Rev.*, **91**, 1142–51 (*Sept.* 1, 1953).

A theoretical study of the effect of static lattice distortions on the electrical resistivity, electronic thermal conductivity and absolute thermoelectric power of monovalent metals, based on a transport equation which follows from straightforward quantum-statistical arguments. Employing an iteration method, this equation is reduced to a set of integral equations in one independent variable, and solved explicitly for $T \gg \Theta$. The three effects are thus studied for a distorted metallic lattice at high temperatures, and information obtained concerning the anisotropy of a metal, containing certain types of imperfections, in a much wider temperature range. The striking result is that this transport equation yields the same results as the simplified one employed by Mackenzie and Sondheimer, provided that $T \gg \Theta$ and that the effect of the lattice distortions on the three properties mentioned above is small. To illustrate these general formulae, the case of an array of parallel edge dislocations is treated in detail. Results are expressed in terms of a quantity Q, which is proportional to the ratio of the changes in absolute thermoelectric power and electrical resistivity. For plastically deformed noble metals, the observed values of Q are appreciably larger than the corresponding theoretical values for dislocation arrays of the type mentioned above. A.

539.11 : 538.22 : 536.63

2638. Effects of band shape on the magnetic and thermal properties of metals and alloys. E. W. Elcock, P. Rhodes and A. Teviotdale. *Proc. Roy. Soc. A*, **221**, 53–77 (*Jan.* 7, 1954).

The temperature variations of the electronic contributions to the paramagnetic susceptibility, χ, and specific heat, C, of metals are calculated for various forms of electronic energy bands. The band shapes considered are those corresponding to density of states relations of the form $d\nu/d\varepsilon = \nu' = 2a_n\varepsilon^n$ for $n = 1, 2, 3$ and $\nu' = 2(a_0 + a_3\varepsilon^3)$ for a range of values of (a_3/a_0). The variations of χ and C are presented graphically for effectively the whole temperature range in each case. It is shown, in particular, that with $\nu' = 2a_n\varepsilon^n$, χ decreases monotonically with increasing temperature, T, but that with $\nu' = 2(a_0 + a_3\varepsilon^3)$ the χ, T curve may have a maximum for a certain range of values of (a_0/a_3). The effects of band closure and band overlap are also considered, and results are presented graphically for χ and C as functions of temperature for (*a*) a single closed rectangular band, (*b*) two overlapping infinite rectangular bands and (*c*) two overlapping closed rectangular bands. The status of the collective electron treatment of metals, on which the present work is based, is briefly discussed with respect to the more general theory of metals. A short discussion is also given of the theoretical results in relation to the relevant experimental results, and, in particular, in relation to the properties of palladium and of some of its alloys with silver. A.

539.11

2639. Some consequences of possible degeneracy of energy bands in Ge. E. N. Adams II. Letter in *Phys. Rev.*, **92**, 1063 (*Nov.* 15, 1953).

Discusses some of the consequences of the recently suggested [see Abstr. 3475 (1953)] degeneracy at the band edge of both conduction and valence bands in Ge. A changed interpretation of existing data on carrier densities would be required, and the effective mass ratios of the carriers would have to be less than unity. The deformation potential as the dominant source of lattice scattering would have to be abandoned. A. E. DE BARR

539.11

2640. The compressibility of metallic aluminium. S. Raimes. Note in *Proc. Phys. Soc.* [*London*] *A*, **66**, 949–51 (*Oct.*, 1953).

An application of the method previously developed for divalent metals [Abstr. 4503 (1952)] to metallic aluminium. The lattice constant, compressibility, cohesive energy and total energy are calculated. The calculated curve giving the compression as a function of pressure (up to 10^5 atm.) is in good agreement with experiment. It is concluded that, for certain purposes, the valency electrons in the metal may be regarded as approximately free. The calculation is compared with one by Gáspár [Abstr. 2581 (1953)] using a different method. E. P. WOHLFARTH

539.11 : 539.132

2641. Correlation energy in metals and the cohesive energy of metallic sodium. S. Raimes. *Proc. Phys. Soc.* [*London*] *A*, **67**, 52–6 (*Jan.*, 1954).

The method of Wigner and Seitz (1934) for calculating the cohesive energy of metallic sodium is compared with a recent method of Löwdin [Abstr. 2021 (1952)], and reasons are given for preferring the former. A simple calculation shows that Löwdin's use of the LCAO method in constructing his one-electron functions must give rise to an error in the energy greater than the correlation energy as estimated by Wigner, so that Löwdin's results should not be used in assessing the accuracy of Wigner's formula. A.

539.11

2642. Schottky defects in solid solutions. W. E. Wallace and R. A. Flinn. Letter in *Nature* [*London*] **172**, 681–2 (*Oct.* 10, 1953).

Density measurements indicate large changes with composition in the number of Schottky defects in mixed alkali halides and other solid solutions. Thermodynamic theories of solid solutions neglecting these changes cannot be considered satisfactory. W. M. LOMER

MOLECULAR STRUCTURE 539.13

539.13

2643. Note on the interchange of rotational and vibrational energy in collisions of diatomic molecules. E. H. Kerner. *Phys. Rev.*, **92**, 899–900 (*Nov.* 15, 1953).

The results of a previous report [Abstr. 649 (1954)] are extended to molecule-molecule scattering with interchange of rotational or vibrational energy. Differential and total cross-sections for O_2–N_2 scattering are given. A.

539.13

2644. The rate of recombination of iodine atoms in solution. R. Marshall and N. Davidson. Letter in *J. chem. Phys.*, **21**, 2086 (*Nov.*, 1953).

The technique used for the gas-phase recombination [Abstr. 5613 (1953)] has now been applied to measurements in the non-polar solvents n-C_7H_{16} and CCl_4. Experimental modifications are described in detail. Measured values of k at room temperature were $2{\cdot}2(\pm 0{\cdot}4$ mean deviation$) \times 10^{10} M^{-1} sec^{-1}$ in C_7H_{16}, and $0{\cdot}72(\pm 0{\cdot}11) \times 10^{10} M^{-1} sec^{-1}$ for CCl_4. The initial degree of dissociation obtained by extrapolation to zero time gave a measure of the quantum yield ϕ, estimated values being $\phi = 0{\cdot}41(\pm 0{\cdot}32)$ and $0{\cdot}19(\pm 0{\cdot}07)$ respectively. Agreement with other methods is satisfactory. The effective collision diameters were calculated on the assumption that the recombination is diffusion-controlled with zero activation energy. H. H. GREENWOOD

539.13 : 535.33

2645. The dissociation energies of the gaseous oxides CrO and FeO. A. Lagerqvist and L. Huldt. *Z. Naturforsch.*, **8a**, 493–8 (*Aug.*, 1953) *In German.*

Measurements of the intensity of emission of atomic lines of the metallic element M in an acetylene-air flame at different temperatures enables the dissociation energy of the oxide MO to be determined: knowledge

of the absolute f-values for the lines is not required. The dissociation energies of CrO and of FeO are found to be $5{\cdot}3 \pm 0{\cdot}4$ and $4{\cdot}3 \pm 0{\cdot}5$ eV respectively.

R. F. BARROW

539.132

2646. Polarizability of the hydride ion and the dipole moments and binding energies of the alkali metal hydrides. A. P. ALTSHULLER. Letter in *J. chem. Phys.*, **21**, 2074–5 (*Nov.*, 1953).

If the calculations of Klemperer and Margrave [Abstr. 4509 (1952)] are corrected for a H^- ion polarizability nearer 10×10^{-24} than $1{\cdot}8\times10^{-24}$ cm^3, then the dipole moments appear negative and the binding energies are in serious error for the alkali hydrides. It seems that the approximations involved are not valid when there is a large penetration of the H^- ion electron cloud by the positive ions.

D. H. WHIFFEN

539.132

2647. A one-dimensional wave equation for hydrogen bonds. C. E. NORDMAN AND W. N. LIPSCOMB. Letter in *J. chem. Phys.*, **21**, 2077–8 (*Nov.*, 1953).

A solution of the Schrödinger equation is indicated, based on a Morse function for the O–H potential, with the potential energy of H between 2 O atoms, $2d$ apart, of form $V(d+x)+V(d-x)$. J. JACOBS

539.132

2648. Predissociations and CO dissociation energy. J. G. VALATIN. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 1185–6 (*Dec.*, 1953).

Statements by Gaydon in a recent book (*Dissociation energies and spectra of diatomic molecules*, 2nd edition, 1953) are criticized. G. I. W. LLEWELYN

539.132 : 541.14

The photochemical decomposition of nitric oxide by absorption in the (0, 0) and (1, 0) γ-bands. *See Abstr.* 2827

539.132 : 548.737

Molecular compounds exhibiting polarization bonding. *See Abstr.* 2927

539.132 : 535.338.42

Vibration-rotation bands of OH. *See Abstr.* 2274

539.132 : 535.338.42

Infrared emission of the hydrogen-fluorine (H_2–F_2) flame. *See Abstr.* 2275

539.132 : 535.338.42 : 535.375.51

2649. The vibration spectra of helical molecules: infra-red and Raman selection rules, intensities and approximate frequencies. P. W. HIGGS. *Proc. Roy. Soc. A*, **220**, 472–85 (*Dec.* 22, 1953).

The infrared and Raman selection rules for an infinite long-chain molecule having helical symmetry are discussed, and the normal modes of vibration are classified by the use of group theory. A weak-coupling approximation is used to derive relations between the intensities of the variously polarized spectral components arising from a single vibration frequency of the unit out of which the helix is built. A form of matrix perturbation theory is used to obtain some approximate relations between the frequencies of these components; these relations involve the angle ψ relative to the screw axis which separates successive units of the helix and provide, in principle, a method by which this angle may be measured. It is suggested that the methods discussed here may serve as a basis for the interpretation of the spectra of fibrous proteins. A.

539.132 : 548.736.4 : 535.375.54

Fundamental vibrations of $CuCl_2(H_2O)_2$ in copper chloride crystals. *See Abstr.* 2320

539.132 : 535.338.42–15

Rotational constants of carbon dioxide and nitrous oxide. *See Abstr.* 2276–7

539.132 : 535.343–15

Vibrational spectra of fluorinated aromatics. *See Abstr.* 2290–2

539.132 : 535.375.5 : 535.343

Infrared and Raman spectra of tetramethylmethane-d_{12}. *See Abstr.* 2280

539.132

2650. Theoretical researches on acetylenic compounds. I. Electronic structure of acetylene. J. SERRE AND A. PULLMAN. *J. Chim. phys.*, **50**, 447–58 (*Sept.*, 1953) *In French.*

The spectra of acetylenic compounds were compared with those of the corresponding compounds with double instead of triple bonds; some regularities were observed: the lowest electronic bands show red shifts for the acetylenic compounds; the intensities of the N-V transition bands decrease but those of the Rydberg bands increase. The spectra of vinylacetylenes resemble more those of ethylenic than those of acetylenic compounds. For diphenyl-polyenes and -acetylenes it was observed that the red shift shown by the band of greatest wavelength became a blue shift for a higher number of C≡C groups in the compound. In order to interpret these results theoretically, interaction between the two kinds of π-orbitals must be taken into account. The ASMO electronic wave-functions and energies were calculated. Certain parameters were chosen. The calculated shifts in the transitions agree well with those observed. Configuration interaction was applied; but the results were not appreciably affected; the transition $N \rightarrow V$ was somewhat increased. A. J. TAYLOR

539.132

2651. Electronic structure of fulvene. Introduction of configuration interaction. A. JULG AND A. PULLMAN. *J. Chim. phys.*, **50**, 459–67 (*Sept.*, 1953) *In French.*

The electronic structure was calculated first with the simple LCAO method, variations of β being taken into account, and also with the use of configuration interaction. Three- and four-centre integrals were included. The results differed considerably from those obtained by the simple method. The transitions $N \rightarrow V_1$ and $N \rightarrow V_2$ were calculated: the values found were somewhat higher than the experimental values, but the intensities showed good agreement. A comparison was made with the self-consistent field method: the latter predicts dipole moments better, but both methods give equivalent results for transitions and their intensities. A. J. TAYLOR

539.132

2652. The π-energy levels of ethylene. C. M. MOSER. Letter in *J. chem. Phys.*, **21**, 2098–9 (*Nov.*, 1953).

A change in the usual ASMO procedure is proposed: whenever the (11/11) integral occurs in the electron repulsion integrals, its analytical value is replaced by 10·53 eV, found from spectroscopic data. This brings the $v \rightarrow T$ transition predicted for ethylene into good agreement; the $N \rightarrow V$ transition, however, depends on the orbital part of the energy; Ross's additive method leads to excellent values. J. JACOBS

539.132

2653. Calculations of the lower excited electronic energy levels of cyclobutadiene and benzene. W. MOFFITT AND J. SCANLAN. *Proc. Roy. Soc. A*, **220**, 530–41 (*Dec.* 22, 1953).

The method of atoms in molecules, as previously applied to calculations on the ethylene molecule [Abstr. 7015 (1953)] is now used to calculate the energies of the lower electronic levels of the cyclobutadiene and benzene molecules. The calculated excitation energies for the benzene molecule are compared with those determined from the observed spectrum. The results in this case are not so satisfactory as those obtained for the simpler ethylene molecule, but still compare favourably with the results by the ASMO method. A.

539.132

2654. The effect of variation of the dipole moment with internuclear separation on the relative intensities of the Second Negative band system of oxygen. G. POOTS. Note in *Proc. Phys. Soc.* [*London*] *A*, **66**, 1181–4 (*Dec.*, 1953).

Calculations on the relative intensities of the members of a band system of a diatomic molecule are based on the general assumption that the transition dipole moment is independent of the internuclear separation. Results of calculations on the Second Negative system of oxygen are presented to determine the error introduced into the investigation of diffuse band systems when this assumption is made. G. I. W. LLEWELYN

539.132

2655. Study of the perturbation of π-electron resonance by an obstruction at the centres of polymethine molecules, in the approximation of the metallic model. Theory of the spectra of the ions of malachite green, Michler's hydrol, and Bindschedler's green. S. NIKITINE. *J. Chim. phys.*, **50**, 407–14 (*June*, 1953) *In French.*

The obstruction may be due to a deformation or torsion of the chain of nuclei at its centre, the two halves not being perturbed. The metallic model (an extension to molecules of the Kronig–Penney potential used in metal theory) is successfully used to interpret the spectra mentioned. The spectral properties can be derived from those of rosamine, pyronine, and methylene blue, which are compounds with undistorted nuclear frameworks from which the above compounds may be regarded as derived. To this first approximation, the only way in which the sulphur or oxygen atoms in the undistorted compounds influence the behaviour of the π-electrons is to ensure the planarity of the framework over which they move. A. J. TAYLOR

539.132

2656. Quantum theory of the HF molecule. D. KASTLER. *J. Chim. phys.*, **50**, 556–72 (*Oct.*, 1953) *In French.*

A calculation of the energy matrix including 6 states, based on orthogonal Slater atomic orbitals. The dipole moment is 2·7 Debye; the state F^+H^- represents 9·3% of the ground state. Hybridization plays a small part, both for energy and dipole moment. Overlap of the 1*s* orbitals of both atoms is significant, particularly for kinetic energy. J. JACOBS

539.132

2657. Comments on the method of molecular orbitals. A. LAFORGUE. *C.R. Acad. Sci.* [*Paris*] **237**, 997–9 (*Oct.* 28, 1953) *In French.*

The usual way of forming *n*-electron wave functions is to construct independent forms of the atomic orbitals. The choice of coefficients is discussed, with reference to H_3^+. J. JACOBS

539.133 : 539.152.2

2658. Nuclear magnetic resonance signals from a tautomeric mixture. H. S. JARRETT, M. S. SADLER AND J. N. SHOOLERY. Letter in *J. chem. Phys.*, **21**, 2092–3 (*Nov.*, 1953).

2,4-pentanedione and 3-methyl-2,4-pentanedione were shown to be present to the extent of 85 and 30% respectively in their enol forms, by comparing the areas under distinguishable proton magnetic resonance peaks. D. H. WHIFFEN

539.133

2659. Dipole moments of gaseous thallous halides. A. P. ALTSHULLER. Letter in *J. chem. Phys.*, **21**, 2074 (*Nov.*, 1953).

The dipole calculations of Rittner [Abstr. 8108 (1951)] are extended to the Tl halides and agreement with experiment (4·44*D*) for TlCl is found if the polarizability of Tl^+ ion is $2{\cdot}9 \times 10^{-24}$ cm^3, which is lower than to be expected from the observed value, $3{\cdot}50 \times 10^{-24}$ cm^3 in the crystal. The values 4·49 and 4·60*D* are predicted for the dipole moments of TlBr and TlI respectively. D. H. WHIFFEN

539.133

2660. On the calculation of some molecular quantities. A. LAFORGUE. *C.R. Acad. Sci.* [*Paris*] **237**, 1092–4 (*Nov.* 2, 1953) *In French.*

For previous work see Abstr. 6988 (1953). If the general diagrams are known a whole class of specific constants of a molecule are known. The potential and dipole moment are discussed in general terms together with their derivatives by use of an arbitrary parameter later to be particularized. J. JACOBS

539.133 : 535.343–14/15

Comparison of infrared and centimetre spectroscopy for the determination of bond lengths and moments. *See Abstr.* 2283

539.133

2661. A new relation between potential energy and internuclear distance. E. R. LIPPINCOTT. Letter in *J. chem. Phys.*, **21**, 2070–1 (*Nov.*, 1953).

A new potential function of exponential type

involving three parameters is introduced. Calculations based on it are reported for several diatomic molecules. One parameter may be determined from an empirical relation involving several ionization potentials. An approximation to the proposed function was used in a perturbation treatment of the Schrödinger equation to find anharmonicity constants. The agreement between predicted and observed values of these constants and the bond energies is in general better than with other potential functions such as that of Morse. The function may be useful for discriminating between suggested values of bond dissociation energies, and for predicting properties of diatomic and polyatomic molecules. A. J. TAYLOR

539.133

2662. The molecular structure of B_5H_{11}. L. R. LAVINE AND W. N. LIPSCOMB. Letter in *J. chem. Phys.*, **21**, 2087–8 (*Nov.*, 1953).

The parameters for the 4 molecules in the monoclinic unit cell, the space group, boron positions and the B–B- and B–H-distances are given. C. TURNER

539.133 : 548.736.3

Molecular structure of N_2O_2. *See Abstr.* 2907

539.133 : 538.222

2663. Proton magnetic resonance evidence for the planar structure of the urea molecule. E. R. ANDREW AND D. HYNDMAN. Letter in *Proc. Phys. Soc. [London] A*, **66**, 1187–8 (*Dec.*, 1953).

Single-crystal proton magnetic resonance second moments agree well with the planar structure for $CO(NH_2)_2$ and are in sharp disagreement with the model in which the NH_2 groups are rotated by 90° about the C–N link. D. H. WHIFFEN

539.133

2664. On the statistical shape of chain molecules. I. The direction distribution in the persistence model. G. POROD AND F. SMOLA. *Acta phys. Austriaca*, **8**, *No.* 1, 63–88 (1953) *In German.*

In the "persistence" model vectors representing chain length follow one another in such a way that the angle between two consecutive members obeys the same statistical distribution. The problem of intramolecular separation in chain molecules is investigated on the basis of this model; the aim is to establish a distribution function $W(r\theta\phi)$ giving the probability density with which the end of the n-th chain member lies at (r, θ, ϕ). In particular, this paper investigates the direction distribution $W_n(\theta, \phi)$, the general case following in a later paper. The idea of position folding developed by Doetsch is extended to direction finding. J. JACOBS

539.133

2665. Contribution to the study of the dimensions of rigid macromolecules. Comparison of the results of the electron microscope and of the hydrodynamic laws. III. Experimental results obtained with sols of V_2O_5. J. B. DONNET. *J. Chim. phys.*, **50**, 363–76 (*June*, 1953) *In French.*

The basic theories [Abstr. 8628 (1953)] of the various experimental methods [Abstr. 8629 (1953)] for the measurement of the dimensions of macromolecules are examined in the light of the experimental results presented here. Three different sols of V_2O_5, tobacco mosaic virus and carbon black) which form rigid particles largely free from temporal changes, relatively simple in preparation and approximating to the simple geometrical forms of sphere or ellipsoid, have been studied. The properties of the colloidal particles of V_2O_5 considered first, are discussed in relation to the methods of preparation, the X-ray evidence of crystalline structure, and the existence of growth dependent upon the method of preparation and the presence of electrolytes. The solubility in water suggests that these sols should be considered as a suspension of V_2O_5 particles (the dispersed phase) in a solution of V_2O_5 (the molecular phase). The concentration of the dispersed phase for given total concentrations is studied by the intensity of blue light absorbed by the dispersed phase. The lengths of the particles have been measured by the electron microscope and the range of values obtained for the theoretical viscosity calculated from this distribution contains the value obtained experimentally. The coefficient of translational diffusion measured by light absorption at low concentrations for which particle interaction is negligible, is in good agreement with that predicted theoretically for ellipsoidal particles. The coefficient of rotational diffusion measured by flow birefringence is, however, quite different from the theoretical value. This is attributed to the presence of vanadium acid ions in the molecular phase which modify the free rotation of the negatively charged V_2O_5 particles. The axes of the assumed ellipsoidal particles deduced from these measurements are 1692 and 44 Å, in reasonable agreement with the electron microscope measurements.

H. H. GREENWOOD

539.133

2666. Contribution to the study of the dimensions of rigid macromolecules. Comparison of the results of the electron microscope and of the hydrodynamic laws. IV. Experimental results obtained with a sol of tobacco mosaic virus. J. B. DONNET. *J. Chim. phys.*, **50**, 377–9 (*June*, 1953) *In French.*

The validity of the theory of flow birefringence which manifestly disagrees with experiment in the case of V_2O_5 sols, is examined again using a sol of tobacco mosaic virus, the physical properties of which have already been extensively studied. Good agreement is now obtained between experimental results and theoretical predictions which confirms the general validity of the theory. H. H. GREENWOOD

539.133

2667. Contribution to the study of the dimensions of rigid macromolecules. Comparison of the results of the electron microscope and of the hydrodynamic laws. V. Experimental results obtained with an aqueous sol of carbon black. J. B. DONNET. *J. Chim. phys.*, **50**, 380–9 (*June*, 1953) *In French.*

Carbon black sols have been used as the model of rigid sphere particles. The agglomeration of particles which may impair electron microscope measurements is minimized by mounting the specimen on collodion film. The results of diffusion experiments are in good agreement with theoretical predictions. Viscosity measurements satisfy the Einstein formula for the viscosity of an infinitely dilute solution of rigid spheres in a laminar flow in being independent of the velocity gradient, the temperature and the concentra-

tion. Numerical values are, however, in poor agreement with theory. It is concluded from further experimental evidence that agglomeration of particles cannot explain the numerical disagreement which is finally attributed to electro-viscous effects.

H. H. GREENWOOD

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.15

2668. On the influence of the packing on the atom form factor based on the Thomas–Fermi theory. K. UMEDA AND Y. TOMISHIMA. Letter in *J. chem. Phys.*, **21**, 2085–6 (*Nov.*, 1953).

The values of f_0, the atom form factor for the atom at rest, have been determined for 10 values of $k\mu$ and for different lattice spacings ($k = 4\pi \sin\theta/\lambda$). The packed curves converge to the free one, fluctuating about it more rapidly for increasing lattice spacing.

J. JACOBS

539.152.1

2669. The first excited state of nuclei with even proton and even neutron number. P. STÄHELIN AND P. PREISWERK. *Nuovo Cimento*, **10**, 1219–60 (*Sept.*, 1953) *In German.*

Previous work [Abstr. 5973 (1952)] refers to the first excited state of even-even nuclei. A survey shows that the lowest excitation energy of even-even nuclei is a smooth function of the neutron and proton number. In sequences of neighbouring nuclei the excitation energy increases if the number of protons or of neutrons approaches the next magic number. Several nuclei which seemed to disobey this rule were reinvestigated experimentally, and in every case the new data obtained confirm the rule. The 145 keV radiation which accompanies the transmutation of Cl^{34} into S^{34} is an isomeric ($M3$) transition between the known 33-min state and the ground state of Cl^{34}, the half life of which is 1·45 sec. An $O^+ \rightarrow O^+$ transition with an ft-value of 2700 sec leads directly to the ground state of S^{34}. Two different isotopes of antimony, Sb^{120} and Sb^{116}, have indistinguishable half lives of (16 ± 2) min. The 1·3 MeV level which previously was attributed to Sn^{120} belongs to Sn^{116}. The 60-min activity, with a γ-ray of 0·70 MeV, probably has to be reassigned to mass number 115 (instead of 116). In Hg^{196} a reported γ-ray of 175 keV could not be confirmed, and a new line corresponding to a first level at 426 keV was found, which agrees with the authors' rules. Further experiments deal with Mo^{96}, Zr^{92} and Mo^{92}. The dependence of the lowest excitation energy on the number of protons and neutrons is interpreted in terms of the shell model. It is shown that a strong configurational interaction must be assumed, and that in general the first excited state is due to a simultaneous excitation of the neutron and the proton structure. (60 references.) A.

539.152.1

2670. On the existence of a bound state of ^4H. P. SWAN. Note in *Proc. Phys. Soc.* [*London*] *A*, **66**, 1066–7 (*Nov.*, 1953).

Calculations show that no bound state can exist in which the third neutron is in an excited state relative to the component triton group. J. J. WILKINS

539.152.1

2671. Evidence for subshell at $Z = 96$. G. T. SEABORG. Letter in *Phys. Rev.*, **92**, 1074 (*Nov.* 15, 1953).

The strong spin orbit coupling shell model of the nucleus suggests a subshell at $Z = 96$. A critical analysis, mainly of alpha decay data, gives some evidence for such a subshell. P. T. MATTHEWS

539.152.1

2672. Isotopic spin and Coulomb forces. II. Excited states of light nuclei. L. A. RADICATI. *Proc. Phys. Soc.* [*London*] *A*, **67**, 39–43 (*Jan.*, 1954)

For Pt I, see Abstr. 2957 (1953). The isotopic-spin purity of some low-lying excited states in light nuclei is calculated in first order perturbation theory. Special attention is given to the odd parity states in even nuclei. The isotopic spin impurity caused by coulomb forces is shown to be sufficient to account for the electric dipole transition in O^{16} between the 7·12 MeV excited state and the ground state. A.

539.152.1 : 537.533.74

2673. Jastrow's nuclear model for high energy electron scattering. A. L. MATHUR AND K. M. GATHA. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 1075–6 (*Nov.*, 1953).

The various parameters of the model were determined by correlating the postulated nuclear density distribution with nuclear shell structure for $1 \geqslant 3$ and comparing the calculated scattering amplitudes of 15·7 MeV electrons with the experimental values.

J. HUGHES

539.152.1 : 539.17

2674. Recent progress in nuclear physics. M. VERDE. *Nuovo Cimento*, **10**, *Suppl. No.* 3, 280–90 (1953) *In Italian.*

An up-to-date review. L. PINCHERLE

539.152.2

2675. On the nuclear quadrupole moment of Cu^{63}. H. KOPFERMANN, A. STEUDEL, S. WAGNER AND W. WALCHER. *Nachr. Akad. Wiss. Göttingenmath.-phys. Kl. IIa, No.* 1, 1–2 (1953) *In German.*

The h.f.s. of the lines $\lambda = 5700$ and 5782 Å was measured (hollow cathode, Fabry–Pérot interferometer). The coupling parameter $B(^2D_{3/2})$ was found to be $(0{\cdot}14 \pm 0{\cdot}05)\ 10^{-3}\ cm^{-1}$, and hence $Q(Cu^{63}) = (-0{\cdot}13 \pm 0{\cdot}06)\ 10^{-24}\ cm^2$, in agreement with para-magnetic resonance results. L. PINCHERLE

539.152.2

2676. The measurement of nuclear moments of excited states by angular correlation methods. II. K. ALDER, H. ALBERS-SCHÖNBERG, E. HEER AND T. B. NOVEY. *Helv. phys. Acta*, **26**, *No.* 7–8, 761–84 (1953).

It is shown that angular correlation measurements are well suited for the determination of the magnetic moment and the electric quadrupole coupling in short lived excited states. Formulae and graphs are given for various experimental arrangements and spin values between 1 and 7/2. The influence of finite resolving time and delayed coincidence measurements is discussed. Sample calculations are made for the well-known case of Cd^{111}. A.

539.152.2

2677. On the contribution of the tensor forces to quadrupole moments of heavy nuclei. R. GATTO. *Nuovo Cimento*, **10**, 1311–24 (*Sept.*, 1953) *In Italian.*

This contribution is evaluated. A particular assumption is made concerning the interaction, and it is found that, as long as saturation conditions are satisfied, the introduction of tensor forces does not give excessive quadrupole moments to heavy nuclei. A.

539.152.2

2678. The quadrupole moments of nuclei according to the spheroidal nuclear model. II. R. VAN WAGENINGEN. *Physica*, **19**, 1004–10 (*Oct.*, 1953).

For Pt I, see Abstr. 8395 (1952). The energy of a spheroidal nucleus is calculated as a function of the eccentricity. The term linear in the eccentricity turns out to be independent of the form of the potential and proportional to the kinetic energy of the last nucleon (or hole) for a (closed shells $\pm$ 1 nucleon)-nucleus, for various nuclear models. The amount of the quadratic term depends strongly on the nuclear model and is rather uncertain. Therefore in calculating the quadrupole moment one can more safely use the semi-empirical mass-formula. For nuclei with more than one extra nucleon a combination of *jj*-coupling and collective model is proposed in view of the empirical data on quadrupole moments. A.

539.152.2

2679. The 0^+ states of the light odd-odd nuclei. P. STÄHELIN. Letter in *Phys. Rev.*, **92**, 1076 (*Nov.* 15, 1953).

The nuclear radius and the Fermi coupling constant are derived from data on positron emission from three such states, and a definite isotopic spin is assigned to each. The implications are discussed. P. T. MATTHEWS

539.152.2

2680. The moments of inertia of light nuclei. F. J. WIŚNIEWSKI. *C.R. Acad. Sci.* [*Paris*] **237**, 1222–4 (*Nov.* 16, 1953) *In French.*

These are shown to be compatible with a nuclear model consisting of one or more nucleons at rest on the axis of rotation, with the remainder rotating in the form of an annulus. [Continuation of Abstr. 7031 (1953).] A. O. STANESBY

539.152.2 : 535.338.332

2681. Nuclear spin of Bi^{210}. M. FRED, F. S. TOMKINS AND R. F. BARNES. Letter in *Phys. Rev.*, **92**, 1324–5 (*Dec.* 1, 1953).

The resonance line of Bi I, λ3067, shows no hyperfine structure for Bi^{210} indicating that the nuclear spin $I = 0$. Hence the 127th neutron appears to be in a $g_{9/2}$ state. G. E. BROWN

539.152.2 : 535.338.332

The hyperfine structure anomaly of silver. *See Abstr.* 2266

539.152.2 : 538.1

Nuclear magnetism. *See Abstr.* 2563

539.152.2 : 548.7

Nuclear spin relaxation by translational diffusion. *See Abstr.* 2868

539.152.2 : 548.737

Proton magnetic resonance in a single crystal of oxalic acid. *See Abstr.* 2918

539.153

2682. Term values of f^4—electron configuration. A correction. K. SURYANARAYANA RAO. *Indian J. Phys.*, **26**, 427 (*Aug.*, 1952). See Abstr. 8170 (1950).

539.153

2683. Data on level shifts. W. E. LAMB, JR. *Physica*, **19**, 832 (*Sept.*, 1953).

This is a short summary of the agreement between the observed and calculated $2\,^2S_{1/2}$–$2\,^2P_{1/2}$ level shifts for hydrogen, deuterium and singly ionized helium, and the $1\,^3S_1$–$1\,^1S_0$ shift for positronium. From the observed $2\,^2P_{3/2}$–$2\,^2P_{1/2}$ shift the fine structure constant can be found directly to have the value $(137{\cdot}0365 \pm 0{\cdot}0012)^{-1}$. The observed shifts for H and D are about 0·6 Mc/s too high. G. FIELD

539.153

2684. On the electron affinities of atomic fluorine, oxygen and lithium. B. L. MOISEIWITSCH. *Proc. Phys. Soc.* [*London*] *A*, **67**, 25–32 (*Jan.*, 1954).

The Ritz variational method in conjunction with an extrapolation procedure has been employed to calculate the electron affinities of atomic fluorine, oxygen and lithium, the values obtained being 3·05, 1·12 and 0·74 eV respectively. In the case of fluorine the accord with the value 3·57 eV found by using the Born–Haber cycle is reasonable. The electron affinity of oxygen obtained from collision experiments is $2{\cdot}2 \pm 0{\cdot}2$ eV, which is considerably larger than the value calculated in this paper. No comparison data are available for lithium. A.

539.153 : 537.531

2685. A precision determination of the *K* excitation potential of some 3 *d* elements. Å. NILSSON. *Ark. Fys.*, **6**, *Paper* 49, 513–92 (1953).

A concave crystal spectrometer was to determine the intensity function of *K* emission lines in the neighbourhood of the excitation potential for some 3*d* elements. A method was worked out to obtain pure targets under vacuum conditions and to suppress the contamination velocity in order to get reproducible intensity measurements of the characteristic radiation. The X-ray tube was reconstructed and equipped according to this method. A Geiger counter was constructed with high efficiency in the wavelength region 1·5–2·6 Å. The intensity function was recorded and the *K* excitation potential determined for the $K\alpha_1$, $K\alpha_2$ and $K\beta_1$ lines of chromium and the $K\alpha_1$ line of titanium, iron, cobalt, nickel and copper. The intensity function was recorded for Cr $K\alpha_1$ at a target temperature of 1000°C. An isochromat was recorded, containing the quantum limit of the continuous spectrum and the excitation curve for the Cr $K\beta_1$ line. A proof is given for the necessity of work function correction in the determination of the excitation potential. A summary in absolute and international volts is given of the excitation potentials measured. Voltage differences and intensity characteristics for the structure of the excitation curves are also given. The electronic and radiative excitation is discussed. A comparison of the absorption edges and excitation curves is given. A

value of h/e is obtained from the K excitation potentials and the K absorption edges for the elements 26 Fe to 29 Cu. The result is $(1{\cdot}3794 \pm 0{\cdot}0006)/10^{-17}$ erg.sec./e.s.u. L_{III} and $M_{II,\,III}$ edges are calculated for the 3*d* elements investigated. An attempt is made to explain the structure of the intensity curves from the band theory of metals. A.

539.153.4

2686. Spin-spin interaction of electrons and the ionization energy of helium. A. M. Sessler and H. M. Foley. Letter in *Phys. Rev.*, **92,** 1321 (*Dec.* 1, 1953).

A term in the magnetic interaction of the two electrons in helium, which appears to have been omitted in previous calculations of the energy levels of He, is pointed out. Its effects are calculated for the ground state of He, for various approximations to the wave function. G. E. BROWN

539.153.4

2687. The relativistic correction to the ground-state of helium. A. M. Sessler and H. M. Foley. Letter in *Phys. Rev.*, **92,** 1321–2 (*Dec.* 1, 1953).

Relativistic effects are calculated, employing the Hartree and Hylleraas approximations to the wave-function where each is suitable. The discrepancy between the calculated and the observed ionization energy is reduced slightly. G. E. BROWN

539.153.4

2688. The influence of configurational interaction on the theoretical values of the polarizability of helium. J. A. Abbott and H. C. Bolton. *Proc. Roy. Soc. A*, **221,** 135–41 (*Jan.* 7, 1954).

The unperturbed ground-state wave function of helium is expressed in terms of functions arising from different configurations using the work of Taylor and Parr [Abstr. 5995 (1952)]. It is shown how the field-dependent part of the perturbed wave function can be constructed from functions of the right symmetry using the perturbing potential and the ground-state configurational functions containing variable parameters, which have their best values chosen by a variational method. With the successive addition of configurations there is a satisfactory convergence from the lower side towards the true value of the polarizability. The method should be suitable for any wave function constructed from configurations. A.

539.155.2 : 537.525

2689. Enrichment of isotopic molecules in the direct current glow-discharge. II. The multiplication effect. Enrichment of heavy hydrogen. H. D. Beckey, W. E. Groth and K. H. Welge. *Z. Naturforsch.*, **8a,** 556–62 (*Sept.*, 1953) *In German.*

The enrichment of D in D–H mixtures near the cathode of a d.c. glow discharge previously observed [Groth and Harteck, *Naturwissenschaften*, **27,** 390 (1939)] is systematically investigated. The dependence of the enrichment on length and cross section of the discharge tube, current, pressure, temperature and wall conditions is examined. The results are interpreted quantitatively as a multiplication of the primary effect (which is due to the slower rate of recombination of the D^- ions) by axial convection currents set up by the discharge. H. LONDON

539.155.2 : 541.135

2690. The isotope effect of electrolytic migration of the silver ions in molten silver chloride. S. Floberg, A. Klemm and C. Lang. *Z. Naturforsch.*, **8a,** 562–4 (*Sept.*, 1953) *In German.*

The relative difference $\Delta w/w$ of the ionic migration velocity w for Ag^{107}/Ag^{109} with respect to the Cl ions is 0·0012. The resulting mass effect

$$\mu = (\Delta w/w)/(\Delta m/m) = 0{\cdot}064 \pm 0{\cdot}006$$

confirms the rule [Abstr. 2046 (1952)]

$$\mu = -0{\cdot}15[2{\cdot}1\ m^-/(2{\cdot}1m^- + m^+)].$$

H. LONDON

539.155.4 : 548.7

Absolute value of Avogadro's number from X-ray measurements on crystals. *See Abstr.* 2861

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08 : 539.167

2691. Preparation of a radium D-E-F standard solution. F. Begemann and F. G. Houtermans. *S.B. Österr. Acad. Wiss. IIa,* **161,** *No.* 7–8, 245–9 (1952) *In German.*

The method of emanation was used for the preparation. If a definite amount of Rn is enclosed and left for a sufficiently long time, RaC and RaC″ are formed in radioactive equilibrium. As the hard γ-rays of radium originate from these products, comparisons with a standard make it possible to calculate the exact amount of RaD originally enclosed. Two tubes were treated in such a way, and the activity of the preparation could be accurately calculated. A. J. TAYLOR

539.16.08 : 539.167

2692. Preparation of linear RaDE sources from very pure radium emanation. P. Weinzierl. *S.B. Österr. Akad. Wiss. IIa,* **161,** *No.* 7–8, 251–63 (1952) *In German.*

For investigations of the upper limit of the momentum spectrum of β-rays emitted by RaE, some sources approaching linear shape were required, so that at a length of 10 mm the diameter should not exceed 0·2 mm. These preparations were obtained from very pure radium emanation in glass capillaries. The emanation was allowed to die out. The RaD present made it possible to use the preparation for a considerable time with practically constant activity. The emanation was carefully purified, and because the helium formed was removed and new emanation put in its place, the activity of the source was increased. This purpose was also achieved by cooling in liquid air and compression. The activity of each source was measured. Experimental details are described.

A. J. TAYLOR

539.16.08 : 778.34

2693. On a new method for the study of radioactive phenomena: cine-nucleography. M. Laporte. *C.R. Acad. Sci.* [*Paris*] **237,** 889–90 (*Oct.* 19, 1953) *In French.*

By arranging a radioactive source to move with a given speed close to the surface of a nuclear emulsion

it is proposed to investigate the time interval and the order of emission in cases where the radioactive emission of two types of particles is nearly simultaneous. See also Abstr. 2704 (1954). A. C. COATES

539.162 : 539.152.1

2694. Angular correlation of nuclear radiations. *Science*, **118**, 635–42 (*Nov.* 27, 1953).

A non-specialist survey of the application of angular correlation process studies to the nuclear structure problems, with some account of detecting techniques. 23 refs.

539.163.1

2695. On the statistical analysis of radioactive decay. N. Hole. *K. Norske Vidensk. Selsk. Forhandl.*, **24**, *No.* 19, 85–9 (1951) *In German.*

A method is given for finding the statistical distribution of the decay constant as estimated from a set of decays occurring at times $t_1, t_2 \ldots t_4$. [See Abstr. 9659 (1951).] W. J. SWIATECKI

539.163.1

2696. The half-life of $^{181}Ta^m$ and the delayed coincidence method. H. S. Murdoch. Note in *Proc. Phys. Soc.* [*London*] *A*, **66**, 944–9 (*Oct.*, 1953).

The half-life (610 keV state) has been measured by both variable delay and variable pulse-width methods, giving a mean result $18{\cdot}8 \pm 0{\cdot}5$ μsec. The theory of the methods is discussed. A value 46 ± 4 days for the half-life of Hf^{181} is also reported. J. J. WILKINS

539.163.2

2697. A study of the neutron deficient terbium isotopes. M. A. Rollier and J. O. Rasmussen, Jr. *R.C. Accad. Naz. Lincei*, **14**, 526–30 (*April*, 1953) *In Italian.*

No new active isotopes were found. Various data are given on several activities and their interpretation is discussed. L. PINCHERLE

539.163.2

2698. The decay of Mg^{27}. H. Daniel, L. Koester and T. Mayer-Kuckuk. Note in *Z. Naturforsch.*, **8a**, 447–8 (*July*, 1953) *In German.*

Three separate investigations failed to confirm the decay scheme suggested by Beneš, Hedgran and Hole [Abstr. 1899 (1948)]. They agreed with a suggested scheme in which 41·4% decay with a β of 1·59 MeV and 58·2% with one of 1·75 MeV. These are followed by γ's. 0·34% go direct by a 2·60 MeV β to Al^{27} ground state. F. R. HOLT

539.163.2

2699. Natural radioactivity of wolfram. W. Porschen and W. Riezler. Note in *Z. Naturforsch.*, **8a**, 502 (*Aug.*, 1953) *In German.*

Examination of nuclear emulsions impregnated with wolfram compounds shows an α-particle group of energy ~ 3·2 MeV; the corresponding ½-life is estimated as $\sim 6 \times 10^8$ yr, and the abundance of the isotope responsible (possibly W^{178}) $\sim 2{\cdot}5 \times 10^{-9}$. A. O. STANESBY

539.163.2

2700. On the nuclear isomerism of Ir^{192}. G. Weber and A. Flammersfeld. Note in *Z. Naturforsch.*, **8a**, 580–1 (*Sept.*, 1953) *In German.*

This was investigated with a Slätis–Siegbahn β-spectrometer. Results are given as curves and are discussed. No evidence for unknown isomeric transitions from Ir^{192m} (1·45 min) was found. 0·1% was β-decay. F. R. HOLT

539.163.2 : 537.533.72

Magnetic-lens spectrometers. Study of the radiation of Au^{198} and As^{76}. *See Abstr.* 2487–8

539.163.2 : 539.172

2701. Bromine isotopes produced by carbon-ion bombardment of copper. J. M. Hollander. Letter in *Phys. Rev.*, **92**, 518 (*Oct.* 15, 1953).

Isotopically varied CuO targets were bombarded with ions of around 90 MeV. 95 ± 3 min Br^{75}, 36 ± 2 min Br^{74} and a 4 ± 1 min bromine activity were found. The 16 hour Br^{76} positron emitter was not observed. F. R. HOLT

539.164

2702. The energy distribution of the α-particles from nuclear evaporation taking account of the division. I. G. Süssmann. *Z. Naturforsch.*, **8a**, 404–16 (*July*, 1953) *In German.*

Attempts to explain as a kinetic effect the frequent emission of slow α-particles from stars in photographic emulsions. It is assumed that the highly excited nuclei divide into two approximately equal parts with such large velocities that the energy distribution of the evaporated α-particles is greatly distorted. The time scale of the division is estimated on the basis of the liquid drop model and compared with that for evaporation. J. HUGHES

539.164

2703. The alpha spectra of Cm^{242}, Cm^{243}, and Cm^{244}. F. Asaro, S. G. Thompson and I. Perlman. *Phys. Rev.*, **92**, 694–702 (*Nov.* 1, 1953).

The α and γ spectra of Cm^{242}, Cm^{243}, and Cm^{244} have been studied with an α-particle spectrograph and γ-ray scintillation counters. Cm^{242} has α groups of 6·110 (73·7%), 6·066 (26·3%) and 5·964 MeV (0·035%) and γ rays of 44 (0·041%), 100 (0·006%), and 157 keV (0·0027%). Cm^{243} has α groups of 5·985 (6%), 5·777 (81%) and 5·732 MeV (13%) and γ rays of 104, 226 and 278 keV in coincidence with the 5·777 MeV α group. Cm^{244} has α groups of 5·798 (75%) and 5·755 MeV (25%). The spectra are discussed relative to α-decay theory and corresponding excited states reached by β^- decay processes. A.

539.164 : 778.34

2704. Method of measurement of the activity of α-emitters by cine-nucleography. O. Rœhrich-Goussu. *C.R. Acad. Sci.* [*Paris*] **237**, 1230–2 (*Nov.* 16, 1953) *In French.*

See Abstr. 2693 (1954). A Po source was repeatedly moved across a nuclear plate at known velocity. Measurement of the number of tracks produced per unit area yielded the activity to an accuracy ~ 5%. Two alternative methods of plate scanning, and the appropriate formulae for the activity, are given. J. J. WILKINS

539.165

2705. The β^+-spectrum and the K/β^+ ratio of Zn^{65}. T. Yuasa. *C.R. Acad. Sci.* [*Paris*] **237**, 1077–80 (*Nov.* 2, 1953) *In French.*

A fresh study using a semicircular magnetic and a scintillation spectrometer shows the positron spectrum to have the allowed shape down to 120 keV with

a slight excess of positrons below this energy. The $(K/\beta^+)_{total}$ ratios by the two methods are 40 ± 5 and 42 ± 2 respectively. A. O. STANESBY

539.165

2706. The β spectrum of RaD. E. HUSTER. Letter in *Phys. Rev.*, **92**, 1076 (*Nov.* 15, 1953).

This was examined in a proportional counter containing RaD as lead tetramethyl. The max. energy E_0 is 23·0 ± 2·5 keV [cf. 15·2 ± 1 keV of Jaffé and Cohen, Abstr. 2655 (1953)]. A. O. STANESBY

539.165 : 537.531

Characteristic X-rays from thick β-ray sources. *See Abstr.* 2467

539.165 : 539.166.82

2707. *K*-Auger electrons, positrons, and conversion electrons of Zn^{65} above 5 keV. J. F. PERKINS AND S. K. HAYNES. *Phys. Rev.*, **92**, 687–93 (*Nov.* 1, 1953).

The momentum distributions of *K*-Auger electrons, positrons, and conversion electrons of Zn^{65} have been measured in a magnetic lens spectrometer, with very thin sources and counter windows. The positron Fermi plot was found to be linear from the end point of 325 ± 3 keV to about 50 keV. The positron decay is simple, contrary to some previously published results. From the observed intensities of *K*-Auger electrons, positrons and conversion electrons and values of capture branching ratio, fluorescence yield and *L*-to-*K* capture ratios taken from the literature, the intensity ratios of the various spectral components have been obtained. The resulting conversion coefficient, $\alpha = (2{\cdot}56 \pm 0{\cdot}29) \times 10^{-4}$, agrees with other experimental determinations and strongly suggests an *E*2 transition. The observed ratio of *K*-capture to the ground state to positrons, 28·0 ± 3·2, is in satisfactory agreement with the recently calculated theoretical value of 29·0 for an allowed transition. This agreement, in view of the high *ft* value, establishes the *l*-forbidden character of the transition. A.

539.165.08 : 537.542

2708. The use of two scintillation counters in beta ray spectroscopy. C. F. G. DELANEY. *Sci. Proc. Roy. Dublin Soc.*, **26**, 173–8 (*Sept.* 9, 1953).

The merits of various forms of pulse height analysers used in nuclear spectroscopy are reviewed. A simple pulse height analyser based on oscilloscope presentation of the pulses on a screen is described. This is claimed to be faster and more accurate than the method in which the pattern of pulses is photographed and the pulse height spectrum subsequently found by taking a microphotometer trace of the film. In the instrument described the oscilloscope screen was masked except for a small aperture which was viewed by a photomultiplier tube connected to a scaling circuit. To scan the energy spectrum, the complete pattern on the screen was moved by means of the oscilloscope *Y* shift. For a sufficiently small aperture the resolution was limited only by the width of the oscilloscope trace. A plot of the β-ray spectrum of Cs^{137} shows an energy resolution of 11% for the conversion line at 0·63 MeV which indicates that the pulse analyser was not limiting the resolution. D. R. CHICK

539.165.08 : 539.166.08 : 537.542

2709. Beta and gamma spectrometer with proportional counter. G. BERTOLINI, A. BISI AND L. ZAPPA. *Nuovo Cimento*, **10**, 1424–33 (*Oct.*, 1953) *In Italian.*

The description is given of a proportional counter, used for the analysis of β- and γ-spectra. The counter is permanently attached to a purifier which allows the continuous purification of the gas during the measurements. The variation of the resolving power of the spectrometer with energy is studied. It is concluded that, at least up to 50 keV, this resolving power is limited only by the fluctuations in the number of ion pairs released in the gas by the ionizing particle and by the fluctuations introduced by the statistics of the multiplication process. In an application of the technique, the fluorescence yield of the *K* shell of argon was measured. The value obtained was: $\omega_K = 0{\cdot}085_0 \pm 0{\cdot}002_7$. A.

539.165.2

2710. On the relations between beta-decay nuclear matrix elements. M. YAMADA. *Progr. theor. Phys.*, **9**, 268–72 (*March*, 1953).

Ahrens and Feenberg [Abstr. 4574 (1952)] have found several relations between the first forbidden β-decay nuclear matrix elements. In this paper, they are extended to the general forbiddenness and compared with experiments. A.

539.165.2

2711. Contribution to the theoretical study of β radioactivity and of *e*-capture: influence of the electron cloud. P. BENOIST-GUEUTAL. *Ann. Phys.* [*Paris*] **8**, 593–645 (*July–Aug.*, 1953) *In French.*

The relative merits of different methods [Schrödinger ψ, Hartree field, relativistic ψ, J. R. Reitz's ψ (relativistic ψ in a Thomas–Fermi–Dirac statistical atom, Univ. of Chicago 1949)] of estimating the electron densities at the nucleus, especially of *K* and *L* electrons are discussed, taking account of screening. The results are compared with the ratio P_L/P_K of observed *e*-capture probabilities. The influence of chemical bindings on *e*-capture is estimated and compared with Paris and Berkley experiments on Be, $BeCl_2$, BeF_2, BeO, where effects of $\Delta P/P \sim 0{\cdot}1\%$ seem to exist. The transition probability for *e*-capture or β-emission is formulated for a general system consisting of a nucleus and its electrons. The effect of the change in the nuclear charge on the electron cloud is reflected in a modification of P_L/P_K which, for Be^7, becomes 2·2 to 3·3 times the value calculated with fixed *Z*. The correction decreases with increasing *Z*. In β-decay the form of the spectrum is only slightly affected, though the interpretation of the maximum β-energy must be modified and the corrections are always more important than the nuclear recoil. Formulae are derived for the probability of excitation of the final atom due to the sudden change in *Z*. W. J. SWIATECKII

539.166

2712. Study, by γ- and X-radiations, of low-energy excited levels in some heavy nuclei. M. RIOU. *Ann. Phys.* [*Paris*] **8**, 535–92 (*July–Aug.*, 1953) *In French.*

Using absorption methods, the energies and intensities of γ-rays and X-rays from Io, RTh, RaF, Pa_2, $MsTh_1$, Ac and AcK have been studied. The results obtained, together with other available data (120

references), are used in discussing decay-schemes and energy-level characteristics. It is concluded, in particular, that the first excited levels of Ra, ThX and RaG are 2^+ levels (explanations being suggested for some apparently inconsistent experimental data), and that levels of 30 keV and 38 keV excitation exist in $MsTh_2$ and RAc respectively. J. J. WILKINS

539.166

2713. The influence of combined electric and magnetic interaction on gamma-gamma directional correlation. H. ALBERS-SCHÖNBERG, K. ALDER, E. HEER, T. B. NOVEY AND P. SCHERRER. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 952–4 (*Oct.*, 1953).

Theoretical expressions are given for correlations perturbed by electric and magnetic fields perpendicular to the plane of the counters. Preliminary experimental data on Cd^{111} are reported. J. J. WILKINS

539.166

2714. Numerical calculations for the angular distribution of gamma radiation emitted by oriented ^{58}Co nuclei. J. A. M. COX, S. R. DE GROOT AND C. D. HARTOGH. *Physica*, **19**, 1119–22 (*Nov.*, 1953).

The theoretical results for the angular distribution of γ-radiation emitted by oriented radioactive nuclei are applied to the case of Co^{58} nuclei. The angular distribution function of the γ-radiation has been calculated for an arbitrary degree of nuclear orientation and in dependence of a parameter, which describes the character of the β^+-transition or the K-capture preceding the γ-transition. A.

539.166

2715. The angular distribution of gamma radiation from oriented ^{60}Co nuclei and the influence of the character of the preceding beta-transition. J. A. M. COX, S. R. DE GROOT AND C. D. HARTOGH. *Physica*, **19**, 1123–6 (*Nov.*, 1953).

Numerical values are given for the angular distribution of γ-radiation emitted by oriented radioactive Co^{60} nuclei. The calculations have been performed for the case that the spin of Co^{60} has the normally accepted value 5, as well as for the case that the spin is 4. Numerical results are given for an arbitrary degree of orientation of the initial Co^{60} nuclei and, in the second case, in dependence on a parameter which describes the character of the β-transition preceding the γ-transition. The numerical figures suggest a possibility of obtaining information on the β-interaction from confrontation with experimental γ-ray distributions. A.

539.166

2716. Angular correlation of the γ–γ cascade of $^{214}_{84}Po$. F. DEMICHELIS AND R. MALVANO. *Nuovo Cimento*, **10**, 1359–66 (*Oct.*, 1953) *In Italian.*

Gamma-rays from the decay of Po^{214}_{84} were studied by means of scintillation counters. Two different types of cascades contribute to the observed angular correlation. On the basis of these experimental results a plausible assignment is made of parities and angular momenta to the energy levels giving rise to the observed ray cascades. A.

539.166 : 539.163.2

2717. Gamma rays emitted from ^{60}Co, ^{56}Mn, ^{187}W, ^{128}I, ^{104}Rh. E. GERMAGNOLI, A. MALVICINI AND L. ZAPPA. *Nuovo Cimento*, **10**, 1388–405 (*Oct.*, 1953).

A coincidence arrangement of two single crystal spectrometers, suitable for the analysis of decay schemes of radioisotopes, has been developed and used to study γ-radiations from Co^{60}, Mn^{56} and W^{187}. γ-spectra of I^{128} and Rh^{104} were also examined by means of a single crystal spectrometer. A.

539.166 : 539.172.13

2718. Capture gamma rays from the proton bombardment of Be^9. W. F. HORNYAK AND T. COOR. *Phys. Rev.*, **92**, 675–80 (*Nov.* 1, 1953).

The γ-rays produced at the 0·993 and 1·085 MeV proton capture resonances in Be^9 were studied using a NaI scintillation spectrometer. γ-Rays of energies 0·41, 0·72, 1·02, 1·43, and 7·5 MeV, and energies 0·72, 1·43, 2·0–2·5, and 6·8, MeV were observed for the two levels, respectively. Absolute yields were determined, and the possible decay schemes are discussed. A.

539.166 : 539.172.4

2719. Neutron capture γ rays from deuterium. A. BRACCI, U. FACCHINI, E. GATTI, E. GERMAGNOLI, A. MALVICINI AND G. PERONA. *Nuovo Cimento*, **10**, 949–57 (*July*, 1953).

The spectrum of γ-rays emitted in the reaction $n + p \rightarrow d + \gamma$ was studied by means of a single crystal spectrometer and a pulsed neutron source. No γ lines, whose energy is less than deuteron binding energy (2·23 MeV), were observed within the limits of sensitivity of the detecting device: therefore the probable existence of a bound level of neutron-proton system, which was inferred by Nakagawa is not confirmed. A.

539.166.08 : 537.542

An anticoincidence gamma-ray scintillation spectrometer. *See Abstr.* 2522

539.166.2

2720. Time dependent quadrupole interaction in angular correlation of nuclear radiation. I. Cd^{111}. P. B. HEMMIG AND R. M. STEFFEN. Letter in *Phys. Rev.*, **92**, 832 (*Nov.* 1, 1953).

The directional correlation of Cd^{111} γ–γ radiation was examined as a function of the viscosity of the solution and was in agreement with the theory of Pound and Abragam [Abstr. 6203 (1953)] on the assumption that the quadrupole moment interacts with a randomly fluctuating electric field gradient. Paramagnetic impurities have no effect. D. H. WHIFFEN

539.166.74

2721. The resonant scattering of ^{198}Hg gamma rays W. G. DAVEY AND P. B. MOON. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 956–8 (*Oct.*, 1953).

Measurements using Au^{198} carried on a steel rotor are described. The dependence of scattering on source velocity is as predicted for free γ-ray recoils and no β-recoil. J. J. WILKINS

539.166.75

2722. Attenuation of gamma rays. II. Transmission values for various materials and geometries. G. H. PEEBLES. *J. appl. Phys.*, **24**, 1437–47 (*Dec.*, 1953).

For Pt I, see Abstr. 1669 (1954). A discussion of the effect of variation of the total absorption coefficient on γ-ray transmission probabilities is given, which leads to estimates of the build-up factors for a material of arbitrary atomic number Z. Estimates are made

of the photon and energy densities arising from a plane of sources, a line of sources and a point source in an infinite homogeneous medium, where the material of the medium is (1) iron and (2) lead. A.

539.166.83

2723. The internal conversion electrons emitted in the decay of ionium and radio-thorium. C. J. D. Jarvis. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 1074–5 (*Nov.*, 1953).

Preliminary results of experiments using impregnated nuclear emulsions are reported. J. J. WILKINS

539.166.835

2724. [Two γ-] Pair annihilation in a homogenous magnetic field. E. Kroupa and H. Robl. *Acta phys. Austriaca*, **8**, *No.* 1, 35–41 (1953) *In German.*

The solution of Dirac's equation shows that a magnetic field parallel to the direction of the electron and positron results in weak energy and angular distributions of the 2 γ's emitted, which for fields $\geqslant \sim 10^4$ oersted, might begin to be observable. W. J. SWIATECKI

539.169 : 548

2725. Radiation damage and rate processes. J. W. Marx. Letter in *Phys. Rev.*, **91**, 1564 (*Sept.* 15, 1953).

Discusses the effect of localized inhomogeneities in the concentration of the reactants on the reaction rate of the thermal recovery processes which result after cyclotron irradiation of pure metals at low temperatures. E. H. SONDHEIMER

539.169 : 539.172.4 : 548.7

2726. Radiation damage in insulators. W. Primak, L. H. Fuchs and P. Day. Letter in *Phys. Rev.*, **92**, 1064 (*Nov.* 15, 1953).

Diamond, quartz and other insulators were exposed within a nuclear reactor. The effects, similar to properties of metamict minerals, include changes in density of ~1%, of lattice constant, of energy content, of heat capacity, of refractive index and of X-ray diffraction pattern, and are attributed to fast neutrons. Behaviour under annealing is complex. J. HAWGOOD

NUCLEAR REACTIONS 539.17

539.17

2727. Influence of electric and magnetic fields on angular correlations. A. Abragam and R. V. Pound. *Phys. Rev.*, **92**, 943–62 (*Nov.* 15, 1953).

The theory of the influence on angular correlations of perturbing interactions in the intermediate state is reformulated to allow the description of the effects of time-dependent as well as of static perturbations. For static interactions of the nuclear electric quadrupole moment with crystalline fields of axial symmetry in polycrystalline sources, attenuation factors are calculated for the coefficients of the various terms in the expansion of the correlation function in Legendre polynomials. No matter how strong the quadrupole interaction, some anisotropy must remain for polycrystalline sources but, for the same interaction in simple single crystals, the anisotropy can be either undisturbed or completely destroyed, depending on the orientation of the crystal. Fields of lower symmetry are shown also to leave, for polycrystalline sources, some anisotropy. Expressions for the influence of randomly fluctuating interactions, such as must exist in liquid sources, are calculated and these predict arbitrarily complete destruction of the correlation under certain conditions, but explain the more nearly unperturbed results usually found with such sources. For electronic shells having magnetic moments, the influences of electronic paramagnetic relaxation and of anisotropy of the hyperfine structure interaction are examined. An applied static magnetic field in the presence of static quadrupole interactions in polycrystalline sources is shown to have differing effects depending on the relative strengths of the two interactions. Application of a magnetic field directed toward a counter cannot reduce the disturbance of the intermediate state in liquid sources, except under special circumstances. The influences of an applied field in the presence of time-dependent anisotropic hyperfine structure interactions are discussed. Finally, the feasibility of resonance experiments, for the precise determination of nuclear moments in the intermediate state, is explored. [See also Abstr. 2720 (1954).] A.

539.172

2728. Model with independent particles and excitation of the heavy nucleus. A. Kind and G. Patergnani. *Nuovo Cimento*, **10**, 1375–87 (*Oct.*, 1953) *In Italian.*

The model with independent particles in classical approximation is used for the description of particular features of the excitation of heavy nuclei in high-energy reactions. The dependence of the transmission coefficient at the surface of the nucleus on the incidence angle leads to a residual excitation energy greater than the one obtained neglecting this dependence. Analysing the variation with temperature of the mean free path of nucleons within the nucleus it is seen that when it exceeds 7·8 MeV there is the possibility that the excitation energy concentrates in limited zones producing localized emission. In the particular case of reactions produced by protons of 400 MeV this should lead to an augmentation of the forward collimation of black prongs. It is to be further expected that with rising temperature the building of understructures within the nucleus should intensify with ensuing high percentage of heavy fragments and α-particles in the emission originating from the more excited zones. A.

539.172

2729. Capture of μ-mesons by atomic nuclei. T. Eguchi and M. Ohta. *Nuovo Cimento*, **10**, 1415–23 (*Oct.*, 1953).

The Fermi gas model of the nucleus is used for the calculation of the capture probabilities of negative μ-mesons by nuclei, taking into account the neutron-excess and the motion of the μ-mesons in the nuclei. In heavy elements the probabilities as functions of the atomic number Z turn out to be about 60% of the values obtained from Wheeler's Z^4_{eff}-law. The most probable excitation energies due to the reaction are found less in heavy elements than in lighter ones in contradiction to the experimental results obtained recently. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 2552, 2556

539.172

2730. The interaction of π mesons with atomic nuclei. N. C. Francis and K. M. Watson. *Amer. J. Phys.*, **21**, 659–72 (*Dec.* 1, 1953).

The interactions of π-mesons with nuclei are reviewed and interpreted in terms of the Serber model of nuclear reactions at high energies. This involves introducing the concept of a mean free path for both meson scattering and absorption in nuclear matter. These quantities are discussed in relation to the relevant experimental data. A discussion of the "optical model" of nuclear scattering is also included. A.

539.172.11

2731. Yields of low-energy protons and alphas resulting from high-energy bombardment of Ag. R. W. Deutsch. Letter in *Phys. Rev.*, **92**, 515 (*Oct.* 15, 1953).

Results given earlier [Abstr. 1906, 5057 (1953)] are analysed. Angular distributions are consistent with isotropic emission. Yields support an evaporation model, with higher-energy protons probably from a knock-out process. F. R. HOLT

539.172.13

2732. Cross sections of $(p, 2n)$, (p, pn) and $(p, 2p)$ reactions for copper bombarded with high energy protons. S. N. Ghoshal and T. N. Dave. *Indian J. Phys.*, **27**, 213–22 (*April*, 1953).

A general expression for the cross-section of a nuclear reaction involving the emission of n successive particles after the bombardment of the target nucleus with a suitable projectile is developed. The possibility of emission of various types of particles, like protons, neutrons, etc., in each stage is considered. The general equation is applied to the cases of the emission of two and three particles respectively in a nuclear reaction. The explicit expressions for the cross-sections in these two cases are given. The energy region of the bombardment particle is assumed to be such that the compound nucleus hypothesis holds good. Cross-sections are calculated, based on the equations derived, for $(p, 2n)$, (p, pn) and $(p, 2p)$ processes on Cu^{63} up to the incident proton energy of 22 MeV. Weisskopf's statistical theory of nuclear reactions is applied to carry out the numerical calculations. The results are compared with the experimentally determined cross-sections for $(p, 2n)$ and (p, pn) processes on Cu^{63}. The calculated values are in qualitative agreement with the experimental values. The possibility of the proton and the neutron being emitted as a single deuteron in the (p, pn) process is considered. Its effect is, however, found to be very small up to the incident proton energy considered. A.

539.172.13

2733. Inelastic events caused by high-energy protons in nuclear emulsions. M. Ladu. Letter in *Nuovo Cimento*, **10**, 855–7 (*June*, 1953) *In Italian.*

Gives an analysis of the results in an emulsion of bombardment with 240 MeV cyclotron protons. They were observed with magnifications of 600 and 1300. F. R. HOLT

539.172.13

2734. Angular distributions of gamma-rays from $^{19}F(p,\alpha\gamma)^{16}O$. J. E. Sanders. Letter in *Phil. Mag.*, **44**, 1302–3 (*Nov.*, 1953).

Measurements for the 6·14 MeV and combined 6·91 and 7·11 MeV γ-rays at the 935 and 1381 keV resonances are reported, suggesting 1^+ and 2^- assignments, respectively, to the compound states of Ne^{20} involved. J. J. WILKINS

539.172.13

2735. Heat of reaction in the process $Be^9(d, t)Be^8$. J. Catalá, F. Senent and J. Casanova. *An. Real Soc. Espan. Fis. Quim.*, **48(A)** 323–5 (*Nov.–Dec.*, 1952) *In Spanish.*

Starting from accurate range measurements of $Be^9(d, t)Be^8$ tritons, on Ilford C-2 plates, the energy release in that reaction was found to have a value of $Q = 4{\cdot}60 \pm 0{\cdot}03$ MeV. A.

539.172.13

2736. The angular distribution of the neutrons from the reaction $Li^7(d, n)Be^8$ and the energy levels in Be^8. B. Trumpy, T. Grotdal and A. Graue. *Univ. Bergen Arbok*, **1953**, *No.* 8, 15 *pp.*

Levels in Be^8 at 2·3, 2·9 (broad), 4·1, 4·9 and 7·6 MeV have been located using 680 ± 20 keV deuterons. A preliminary account of this work was given in Abstr. 1913 (1953). M. A. GRACE

539.172.13

2737. Angular distribution of protons produced in the bombardment of carbon-12 by deuterons. I. J. Catalá, F. Senent and J. Casanova. *An. Real Soc. Espan. Fis. Quim.*, **49(A)** 91–6 (*March–April*, 1953) *In Spanish.*

Following the method of Burrows, Gibson and Rotblat [Abstr. 1216 (1952)] the angular distribution of protons from the $C^{12}(d, p)C^{13}$ reaction is studied, in a centre of mass system, working with 7·86 MeV deuterons and the results for the C^{13} ground state and first excited level are given. The experimental results are checked with the theoretical curves given by Butler and the parity and spin of both states are found. A.

539.172.13

2738. Study of heavy particle/gamma ray coincidences. Experimental studies of heavy particle/gamma ray coincidences. Theoretical study of these correlations. Calculation by this method of the spins of some excited levels in light nuclei. J. Thirion. *Ann. Phys. [Paris]* **8**, 489–534 (*July–Aug.*, 1953) *In French.*

Details are given of a series of experiments on deuteron-induced reactions in light elements. The incident deuterons had energies $\leqslant$1100 keV, and absorption methods were used to analyse the emitted proton and alpha-particle groups. The principal results reported are as follows: $Li^6(d, p)$, $Li^6(d, n)$, $O^{16}(d, p)$ and $B^{10}(d, p)$ reactions: p-γ and n-γ correlations associated with the first excited levels of Li^7, Be^7 and O^{17} and with the first and second excited levels of B^{11}, are isotropic (to within about 6%). $Li^7(d, n)$ reaction: with 550 keV deuterons, the n-γ correlation has $41 \pm 3\%$ anisotropy (maximum at 90°). Comparison with theory indicates a $J = \frac{1}{2}$ state of Be^9, p-wave neutrons and $J = 1$ for the

(assumed) 4·9 MeV level of Be^8. With 1100 keV deuterons, no anisotropy was detected. $B^{10}(d, \alpha)$ reaction: no α-γ coincidences (i.e. transitions to the 4·9 MeV level of Be^8) were detected. The theoretical significance of each result is discussed and a general account of α-γ and p-γ (or n-γ) correlation theory is given. An experiment on the $B^{10}(\alpha, p)$ reaction, using Po α-particles, is also reported. No p-γ coincidences attributable to a level at 0·8 MeV in C^{13} were found. J. J. WILKINS

539.172.13

2739. Excitation curve for A(d, $\alpha 2n$) reaction on Ag. L. T. M. ORNSTEIN, R. E. W. KROPVELD AND A. H. WAPSTRA. *Physica*, **19**, 915–18 (*Oct.*, 1953).

The excitation curves for the reactions $Ag^{109}(d, 2p)Pd^{109}$ and $Ag^{107}(d, \alpha 2n)Pd^{103}$ were measured by stacked foil techniques. A.

539.172.13

2740. Angular distributions and yield of the $^{13}C(d, p)^{14}C$ reaction. B. KOUDIJS, F. P. G. VALCKX AND P. M. ENDT. *Physica*, **19**, 1133–39 (*Nov.*, 1953).

Angular distributions have been measured of long-range protons from the $C^{13}(d, p)C^{14}$ reaction at six deuteron energies between 0·30 MeV and 0·65 MeV. Protons were detected using nuclear emulsions. The target consisted of a thin layer of almost pure C^{13} on a thin aluminium backing. The experimental angular distributions agree surprisingly well with Butler's theory (for $l_n = 1$), which seems to indicate that even at these low deuteron energies the $C^{13}(d, p)C^{14}$ reaction proceeds predominantly by stripping. The yield in the foward direction ($\theta = 0°$) also was measured for deuteron energies between 0·25 MeV and 0·675 MeV at 25 keV intervals and for $\theta = 120°$ between 0·50 MeV and 0·70 MeV at 10 keV intervals. Use was made of a thin crystal (NaI) scintillation spectrometer. Indications were found of a resonance at about 0·63 MeV. A.

539.172.3

2741. Photo-induced reaction $Cu^{63}(\gamma, n)Cu^{62}$ produced by the gamma-rays of lithium bombarded with high speed protons. S. SHIMIZU. *Men. Coll. Sci. Univ. Kyoto A*, **25**, 193–208 (*Dec.*, 1949).

A fairly accurate value of the cross-section was determined by the measurements of the induced positron activities produced in copper samples against the total number of irradiated γ-ray quanta. In order to eliminate the effect of self-absorption of positrons of Cu^{62} in the samples, the ratio of activities of samples to those of a monitor sample was plotted as a function of thickness of samples. From this curve a value could be extrapolated which was not affected by self-absorption. The total number of γ-ray quanta concerned was measured with a G.M. counter having a thick lead wall, of which the counting efficiency was computed theoretically. After measurements of the decay constant of Cu^{62} and of various factors concerning the geometrical arrangement and analysis of the experimental data, the cross-section of $Cu^{63}(\gamma, n)Cu^{62}$ for 17·6 MeV $h\nu$ was obtained as $7{\cdot}7_5 \times 10^{-26}$ cm^2 ± 15%, which, however, was increased then to $8{\cdot}5 \times 10^{-26}$ cm^2 ± 15% by taking into account the fact that the lithium γ-rays have a line at 14·8 MeV besides a line at 17·6 MeV. A.

539.172.3

2742. Nuclear photoprotons from silver and bromine with lithium gamma rays. H. WÄFFLER. *Helv. phys. Acta*, **26**, *No.* 7–8, 785–97 (1953) *In German.*

The total cross-section, the energy spectrum and the angular distribution of protons ejected by the lithium γ-rays in nuclear emulsions have been investigated. The average cross-section of the Ag- and Br-isotopes is found to be $3{\cdot}6 \times 10^{-27}$ cm^2. This is of the same order of magnitude as the cross-sections measured in nuclei with appreciably higher proton binding-energies. The energy spectrum of the photoprotons shows a marked peak near the maximum energy (10–12·2 MeV). This peak corresponds to a fraction of ~12% protons of the total, which leave the residual nucleus near its ground state. The angular distribution of the photoprotons for this high-energy group can be described by the expression $J(\Theta) = 0{\cdot}186 + \sin^2\Theta\,(1 + 0{\cdot}65\cos\Theta)$. If one tentatively ascribes the high-energy group to a direct process as proposed by Courant, it follows that for nuclei with high proton binding energies (e.g. Cd^{113}, Sn^{117}, Sn^{118}), the experimental cross-sections are about 20 times larger than the model of Courant predicts. A.

539.172.3

2743. Interaction between nucleon motion and surface oscillations of the nucleus in nuclear photo-effects. A. REIFMAN. *Z. Naturforsch.*, **8a**, 505–22 (*Sept.*, 1953) *In German.*

The collective particle model is used to calculate the resonance breadths important for (γ, n) processes. These are in satisfactory agreement with experiment. The resonance energies are also in agreement with experiment and with the phenomenological model of Jensen and Steinwedel [Abstr. 1231 (1951)]. P. T. MATTHEWS

539.172.3 : 539.163.2

2744. The production of a short-lived activity by irradiation of Pb with X-rays. J. M. REID AND K. G. MCNEILL. Note in *Proc. Phys. Soc.* [*London*] *A*, **66**, 1179–80 (*Dec.*, 1953).

Using 23 MeV X-rays, a cross-section ~0·07 MeV barn was found for production of the 0·8 ± 0·1 sec isomer. J. J. WILKINS

539.172.4

2745. Some new nuclear reactions produced in tin by fast neutrons. Z. WILHELMI, R. BRUNSZ AND C. DABROWSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 105–8 (1953).

The cross-sections for the n, p reactions in Sn^{116} and Sn^{118} were found to be 0·94 and 0·78 mb respectively, for an effective neutron energy of about 12 MeV. These cross-sections are unusually low, probably because the target nuclides contain a magic number (50) of protons. J. M. CASSELS

539.172.4

2746. A photographic pulse spectrograph and the levels of the N^{15} and O^{17} intermediate nuclei. G. v. GIERKE. *Z. Naturforsch.*, **8a**, 567–78 (*Sept.*, 1953) *In German.*

An ionization chamber filled with either N_2 or O_2 was irradiated with neutrons with a continuous energy

distribution. The energy levels were determined from the pulse amplitude distribution measured by the spectrograph. J. HUGHES

539.172.4

2747. Slow neutron velocity spectrometer studies. V. Re, Ta, Ru, Cr, Ga. E. MELKONIAN, W. W. HAVENS, JR AND L. J. RAINWATER. *Phys. Rev.*, **92**, 702–15 (*Nov.* 1, 1953).

For Pt IV, see Abstr. 9735 (1951). New developments in the analysis of data near resonance levels are described. These allow more accurate values of the level constants to be determined from the measured areas above transmission curves and are more general in their applications. The effect of Doppler broadening is also taken into consideration. Transmission data on Re, Ta, Ru, Cr and Ga are presented. The thermal region of Re is well matched by the relation $\sigma = 5{\cdot}0 + 15{\cdot}8E^{-\frac{1}{2}}$. Resonances are found in Re at 2·18, 4·40, 5·92, 7·18, 11·3, 13·1, 17·7 and 21·1 eV. The strong level at 2·18 eV has been studied by the technique of using two samples of different thickness, giving $\sigma_0 = 5700$ barns and $\Gamma = 0{\cdot}090$ eV. The method of curve fitting was also applied to the transmission dip of the thick sample at 2·18 eV and confirms the values of σ_0 and Γ from the area method. Curve fitting was also used on the 4·40 eV level. New data for Ta in the region above 5 eV are presented. Some transmission dips thought previously to be due to one level have now been resolved into two levels. There are levels at 6·11, 10·2, 13·7, 20·0, 24·0, 35·1 and 38·2 eV. The thermal region of Ru is well matched by the relation $\sigma = 6{\cdot}4 + 0{\cdot}39E^{-\frac{1}{2}}$. Resonance levels are observed at 9·8, 15·2, 24·1 and 40·9 eV. The thermal region of Cr is well matched by the relation $\sigma = 3{\cdot}8 + 0{\cdot}7E^{-\frac{1}{2}}$. A resonance level is observed at 3800 eV. The nuclear cross-section of Ga is given by $\sigma = 7{\cdot}3 + 0{\cdot}35E^{-\frac{1}{2}}$ below 5 eV. In addition interference effects occur in the thermal region. Levels were found at 102 eV and 310 eV, with indications of levels at higher energies.

A.

539.172.4

2748. Total cross sections for 169 MeV neutrons. A. E. TAYLOR. Letter in *Phys. Rev.*, **92**, 1071 (*Nov.* 15, 1953).

The cross-sections, determined from good geometry transmission measurements, were:

Hydrogen,	49·2 ± 1·6;
Deuterium-hydrogen,	23·1 ± 2·0;
Carbon,	323 ± 3;
Oxygen,	430 ± 5 mb.

J. HUGHES

539.172.4

2749. The $^{54}Fe(n, p)^{54}Mn$ reaction. G. H. STAFFORD AND L. H. STEIN. Letter in *Nature* [*London*] **172**, 1103 (*Dec.* 12, 1953).

Pile irradiation of iron samples has shown that fast neutrons produce the $Fe^{54}(n, p)Mn^{54}$ reaction with a cross-section about $\frac{1}{14}$ of that for the $S^{32}(n, p)P^{32}$ reaction. J. M. CASSELS

539.172.4

2750. U^{235} fission cross section. D. POPOVIC AND B. GRIMELAND. *JENER Rep., No.* 19, 6 *pp.* (1953).

Cross-section for fission of U^{235} is compared with the activation cross-section of Na and the ratio between them is found to be 1070 ± 2%. It is shown that the $1/v$ law for fission in the resonance region is valid within the limits of the experimental error. A.

539.172.4

2751. The fission yields of Ru^{103} and Ru^{106}. W. H. HARDWICK. Letter in *Phys. Rev.*, **92**, 1072 (*Nov.* 15, 1953).

β and γ counting were used to compare the yields of Ru activities with those of Ba^{140} and Cs^{137}, produced in the slow neutron fission of natural U. Values for fission yields of 2·85 ± 0·16% for Ru^{103} and 0·38 ± 0·03% for Ru^{106} were obtained.

M. A. GRACE

539.172.4

2752. On a single picture of the phenomena of nuclear fission. D. CURIE. *C.R. Acad. Sci.* [*Paris*] **237**, 1401–3 (*Nov.* 30, 1953) *In French.*

Some remarks in connection with the model in which fission occurs through the peeling off of an outer layer covering a core of 50 protons and 82 neutrons. [See Abstr. 2725 (1953).]

W. J. SWIATECKI

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

2753. A contribution to the theory of the decay of μ-mesons. Č. MUZIKÁŘ AND V. VOTRUBA. *Czechoslovak J. Phys.*, **1**, *No.* 2, 65–72 (1952).

Deals with the probability of the spontaneous decay of a μ-meson into one electron and one photon and also the probability of two-neutrino annihilation of the positive μ-meson with an electron in condensed matter. These probabilities are compared with the probability of the standard spontaneous decay of the μ-meson (into one electron and two neutrinos). Attention is called to the possibility of still other modes of μ-meson decay in matter. A.

539.18 : 537.591.1

2754. Contributions to the τ-meson investigation. E. AMALDI, G. BARONI, C. CASTAGNOLI, G. CORTINI AND A. MANFREDINI. *Nuovo Cimento*, **10**, 937–48 (*July*, 1953).

Two τ-mesons were observed in photographic emulsions exposed to cosmic rays at an altitude of 26 000 m and the data are summarized. The process of decay of τ-mesons is considered and by means of a statistical consideration applied to the measurements on τ-mesons observed by various authors, it is proved that the process of decay in 3π is by far the more likely. The spectrum of the decay products of τ-meson is considered and a comparison with the spectrum calculated on the basis of the statistical factors does not allow any definite conclusion to be reached about the possible existence of correlations among the three decay products on account of the very poor statistics available. Then the ratio τ-mesons/π-mesons coming to rest in the emulsions is considered. A comparison is made between the

values of this ratio at balloon and at mountain altitudes. A.

539.18

2755. Velocity distribution of the pair components in π^0 decay. O. HALPERN AND K. BAUMANN. Letter in *Phys. Rev.*, **92**, 1070 (*Nov.* 15, 1953).

Summarizes the main conclusions resulting from a theoretical examination of the dynamics of the decay scheme $\pi^0 \rightarrow \gamma + e^- + e^+$. H. ELLIOT

539.18

2756. Interaction mean free path and charge exchange of the π-mesons. G. SALVINI. *Nuovo Cimento*, **10**, 1018–34 (*Aug.*, 1953).

The nuclear properties of charged π-mesons of high energy (kinetic energy between 200–1000 MeV) were studied by observing the interactions in carbon and lead of the fast secondary particles (shower particles) emitted in cosmic ray nuclear events. The interactions were observed in a large cloud chamber operated at 3200 m altitude; the cloud chamber was controlled with Geiger counters and with photomultipliers. The total cross-section σ_C of the pions in carbon was measured by comparison with lead giving $\sigma_C = 247 \pm 60$ millibarns. This result agrees with those of other experiments with light nuclei. The general indication is that the cross-section for pions of these energies is somewhat lower than the geometrical. The secondary nuclear interactions in which electromagnetic component is emitted were examined. The average number of neutral π-mesons emitted for secondary nuclear interaction is $0{\cdot}31 \pm 0{\cdot}1$. The cross-section σ_{ch} for charge exchange is in the limits $0{\cdot}16\sigma_{total} \leqslant \sigma_{ch} \leqslant (0{\cdot}31 + 0{\cdot}1)\sigma_{total}$. In an attempt to interpret results the values of $\sigma_{ch}/\sigma_{total}$ were estimated, using the results of Anderson, Fermi, Nagle and Yodh with pions of 100–200 MeV against hydrogen. The resulting value $\sigma_{ch}/\sigma_{total} \simeq 1/3$ does not disagree. A.

539.18

2757. The Auger effect and negative meson capture. A. H. DE BORDE. *Proc. Phys. Soc.* [*London*] *A*, **67**, 57–67 (*Jan.*, 1954)

Previous work on the mesonic Auger effect [Abstr. 1945 (1953)] is extended to meson capture in non-circular orbits, and to Auger emission of L shell electrons. Corrections to the theoretical results are discussed and calculations made of the probable Auger emission from heavy elements for capture in photographic emulsions. The results are compared with observations and reasons suggested for a deviation. A.

539.18

2758. Influence of radiation damping on the scattering of pseudoscalar charged mesons by nucleons. S. N. BISWAS. *Indian J. Phys.*, **26**, 617–26 (*Dec.*, 1952).

It is shown that the inclusion of the influence of radiation damping on the scattering of π^+-meson by proton explains satisfactorily the variation of the total scattering cross-section with energy of the incident π^+-meson as experimentally observed by Anderson and by Sachs and Steinberger; for a proper fit to the experimental curve the value of the coupling constant g^2 is $0{\cdot}56$. The well-known Heitler's integral equation for the above problem is, however, solved by the semi-variational method of Ma and Hsueh, because it is not possible to find an exact solution in this case. The corresponding integral equation for the scattering of π^--meson by proton has been exactly solved by Ma; a comparison of Ma's result with the author's shows that experimentally observed ratio of the cross-section of scattering by proton of π^+-meson to that of π^--meson is explained by the weak coupling perturbation method which includes radiation reactions. A.

539.18

2759. π^+-p scattering near 260 MeV. W. B. FOWLER, R. M. LEA, W. D. SHEPHARD, R. P. SHUTT, A. M. THORNDIKE AND W. L. WHITTEMORE. Letter in *Phys. Rev.*, **92**, 832 (*Nov.* 1, 1953).

This was investigated with a hydrogen-filled diffusion cloud chamber. The angular distribution in the centre-of-mass system was found to be anisotropic and asymmetrical, the results being given graphically. The observed angular distribution was in agreement with that calculated using the s and p phase shifts derived from π^--p scattering up to 213 MeV. J. HUGHES

539.18

2760. The total π^--p cross section at 840 and 470 MeV. A. M. SHAPIRO, C. P. LEAVITT AND F. F. CHEN. Letter in *Phys. Rev.*, **92**, 1073 (*Nov.* 15, 1953).

This was measured for collimated and magnetically analysed π^--mesons from the Brookhaven cosmotron with carbon and polythene scatterers and scintillation counter telescopes. The cross-sections were: 840 MeV, 47 ± 5; 470 MeV, 27 ± 5 mb; giving further evidence for a second maximum in the cross-section at ~ 900 MeV. J. HUGHES

539.185

2761. The slow neutron cross section of water. M. DANZKER. Letter in *J. chem. Phys.*, **21**, 2089–90 (*Nov.*, 1953).

The total cross-section of thermal neutrons for hydrogen in water vapour, as a function of the square of the time of neutron flight, has been calculated on the semi-classical MTV model of Messiah. The curve differs noticeably from that observed for liquid water; this is not unexpected, as the infrared spectra of the two phases differ, and the first vibrational level of the gaseous molecule falls in the energy-range considered. Because of molecular association in the liquid phase, the behaviour towards neutrons resembles that of cetane, whereas water vapour follows methane. A. J. TAYLOR

539.185

2762. The effect of inelastic collisions on the slowing-down length of neutrons in a hydrogenous mixture. H. C. VOLKIN. *J. appl. Phys.*, **25**, 83–7 (*Jan.*, 1954).

An expression for the slowing-down length of neutrons in a hydrogenous mixture in which inelastic collisions occur is derived from the rigorous transport equation under the assumptions that (1) the masses of the non-hydrogen nuclei are infinite and (2) the inelastic scattering is of the type in which only discrete well-defined energy levels of the target nucleus are involved. The result is applied to an iron-water mixture. A.

539.185

2763. Evaluation of the interaction effect in *n-p* capture. N. AUSTERN. *Phys. Rev.*, **92**, 670–4 (*Nov.* 1, 1953).

It is found possible to establish by theoretical arguments that the recently measured thermal *n-p* capture cross-section cannot all be ascribed to the neutron and proton magnetic moments, but that about 8% ± 5% must be contributed by an "interaction" magnetic dipole moment. A.

539.185

2764. Impulsed neutron generator. E. GATTI, G. PERONA AND A. PERSANO. Note in *Nuovo Cimento*, **10**, 80–6 (*Jan.*, 1953) *In Italian.*

A 400 kV neutron generator with pulsed ion source, equipped for the spectrography of slow neutrons with the time-of-flight method is described and illustrated. The ion source is of the axial magnetic field type and is fitted with a hot cathode. It gives a pulse rise time of 0·2 μsec. The target current is 3 mA in pulses variable in steps between 1 and 150 μsec. The pulses are triggered by the spectrograph. A lithium target and paraffin moderator are used and neutrons are produced at the rate of 3×10^5 per second per microamp. of target current at 350 kV. F. J. MIRANDA

539.185

2765. Neutron-proton scattering. H. N. YADAV. *Indian J. Phys.*, **26**, 337–46 (*July*, 1952).

The angular distribution and the total cross-section have been calculated for incident neutrons of energy 83 MeV scattered by protons. Interactions considered are of symmetrical type and one with interaction in the even states only, for Yukawa potential with ranges: $1\cdot18\times10^{-13}$ cm for singlet states, $0\cdot80\times10^{-13}$ cm for the central part in the triplet states and $1\cdot60\times10^{-13}$ cm for the non-central part in the triplet states. The constants for the singlet potential are taken to fit the proton-proton scattering and the low-energy neutron-proton scattering. The constants for the triplet potential are determined by the interaction method to fit the binding energy, the electric quadrupole moment and the magnetic moment of the deuteron. The low energy scattering total cross-sections obtained are in agreement with the experimental values. But the high energy (83 MeV) total cross-sections are large as usual, viz. for symmetrical interaction it is $14\cdot6\times10^{-26}$ cm^2 and for interaction in the even states only, it is $12\cdot1\times19^{-26}$ cm^2. A.

539.185

2766. Influence of the electrolytic dissociation and the hydratation of H_2SO_4 molecules on the scattering of slow neutrons. J. A. JANIK. *Acta phys. Polon.*, **11**, *No.* 2, 146–54 (1952).

Coefficients of absorption of slow neutrons in H_2SO_4-water-solutions were measured. At low concentrations of acid the effect of electrolytic dissociation was observed. The results are in agreement with theory if one assumes complete or almost complete dissociation in H^+ and SO_4^- ions up to the concentration of 40% (by wt.). At high concentrations the increase of the absorption coefficient due to the hydratation of H_2SO_4 molecules was observed. A.

539.185 : 538.221

2767. Inelastic magnetic scattering of neutrons from a ferromagnetic crystal. W. MARSHALL. *Proc. Phys. Soc.* [*London*] *A*, **67**, 85–91 (*Jan.*, 1954).

The wave functions and energy eigenvalues of a ferromagnetic crystal at low temperature are obtained assuming a model of two electrons localized on each atom. The results are applied to the problem of inelastic scattering of neutrons following Moorhouse [Abstr. 3015 (1952)]. The effect of assuming two electrons per atom is quite unimportant. However, a more realistic estimate of the exchange integral leads to narrower peaks than predicted by Moorhouse and therefore tends to make the effect easier to observe. A.

539.185.08

2768. Absolute neutron flux from a Raα + Be source. N. K. SAHA AND L. K. RANGAN. *Indian J. Phys.*, **27**, 18–24 (*Jan.*, 1953).

The absolute flux of neutrons from a (Raα + Be) source was determined by the method of "thermalization" [Abstr. 6077 (1952)]. A large volume of $MnSO_4$ solution was activated by thermalized neutrons from the Raα + Be source held at the centre and the solution activity measured by a specially constructed immersion β-ray counter. The activity of Mn^{56} with reference to the neutron beam was calibrated with the help of an end-window β-ray counter designed for the purpose. Detailed corrections for back-scattering, and self-absorption of the β-rays, geometry and efficiency of the end-window counter, finite size of the source, etc., were applied. The absolute flux was determined to be $F_0 = 13\cdot2\times10^6$ neutrons/g.sec with a probable error of ±25%. Values of F_0 determined by other workers for a similar source have been compiled for comparison. The approximate value supplied by the manufacturer of the neutron source is $1\cdot3\times10^6$ neutrons/sec for a 100 mg Ra + Be source of this type, and it agrees well with the present determination. A.

539.185.08

2769. A spectrometer for fast neutrons and the neutron spectrum of Raα + Be. U. SCHMIDT-ROHR. *Z. Naturforsch.*, **8a**, 470–9 (*Aug.*, 1953) *In German.*

The spectrometer covers the range 2–25 MeV. It consists of an ionization chamber telescope filled with hydrogen or methane, the energy distribution of the recoil protons being determined in the primary direction by a coincidence-anticoincidence system. An impulse spectrograph is employed for counting. The resolution of the spectrometer at moderate energies is 300 keV. The spectrometer is used to determine the spectrum of fast neutrons from a Ra–Be source with and without Pb filtering. J. THEWLIS

539.185.08

2770. A proportional counter spectrometer for neutrons. R. GILES. Note in *Rev. sci. Instrum.*, **24**, 986–7 (*Oct.*, 1953).

The counter is of the gas recoil type, an anticoincidence method being used which prevents the registration of pulses due to nuclei which recoil in directions oblique to the chamber axis. The geometry of the counter and the gas filling determines a minimum energy E below which neutron groups do not

give a sharp peak in the pulse distribution. Neutron groups of energy between E and $2E$ can be observed simultaneously for given filling conditions.

D. R. CHICK

STRUCTURE OF SOLIDS 539.2

539.213.28

2771. On the mechanisms of aging in aluminium-silver alloys. I. K. HIRANO. *J. Phys. Soc. Japan*, **8**, 603–8 (*Sept.–Oct.*, 1953).

The specific-heat / temperature curves of age-hardened samples of aluminium-silver alloy have been obtained by the Nagasaki–Takagi method, the results of which are in good agreement with hardness measurements of Köster and Braumann. A discrete step is observed between two clearly defined stages of ageing process, the first of which is attributed to creation of the Guinier–Preston Zone (γ'' phase) and the second to precipitation of the γ' phase and its transformation to the γ phase. The phase limits of γ'' and γ' (or γ) phases respectively are determined and shown in the phase diagram. The results are discussed and compared with the measurements of X-ray diffuse diffraction effects. A.

539.217 : 539.378.3

2772. Changes in specimen dimensions during diffusion. R. W. BALLUFFI AND L. L. SEIGLE. Note in *Naturwissenschaften*, **40**, *No.* 20, 524–5; erratum, *No.* 24, 628 (1953).

An observed displacement of the Matano interface from the original position of the weld interface of a diffusion couple is not a reliable criterion for establishing that a change in shape or volume has occurred during diffusion. A. D. LE CLAIRE

539.219.2

2773. Calculation of an internal stress accompanying the phase change of solids. S. FUJITA. *J. Sci. Res. Inst.* [*Tokyo*] **46**, 53–8 (*June*, 1952).

Assuming that the shape of grains is spherical and the transformation starts from centres of these grains simultaneously, an expression is given for the magnitude of an internal stress p accompanying the single phase change of a solid in terms of the volume change per unit of volume due to transformation, the bulk modulus and the rigidity in the first state, the bulk modulus in the second state; and the radii of spherical solids in the first and second states respectively. A.

539.219.2 : 538.24 : 539.26

2774. Comparison of internal strains in nickel as determined by X-ray and magnetic methods. E. KAPPLER AND L. REIMER. Note in *Naturwissenschaften*, **40**, *No.* 20, 523–4 (1953) *In German.*

Good correlation is found between internal strains in nickel determined from the energy required to magnetize the sample, and the homogeneous part of the internal strain found by X-ray methods.

A. E. DE BARR

539.234 : 531.715

2775. Measurement and control of the thickness of thin films. K. M. GREENLAND. *Vacuum*, **2**, 216–30 (*July*, 1952—publ. *Sept.*, 1953).

The thickness of thin films may in general be measured by gravimetric, photometric, polarimetric or interferometric methods. The principles and some refinements of these methods are described, together with examples of some other methods (X-ray, radioactive tracer and electrical) of more limited application. Most of the methods have also been adapted for the indication or control of the thickness of films deposited by high vacuum or sputtering processes. The films measurable by the methods described range in thickness from a few Ångström units to a few microns. The bearing of the method employed on the meaning of thickness values is briefly discussed. A.

539.234 : 535.323 : 535.345

2776. Evaporated magnesium fluoride films. N. MORITA. *J. Sci. Res. Inst.* [*Tokyo*] **46**, 127–9 (*Sept.*, 1952).

Optical properties of evaporated MgF_2 films on glass were studied. Transmissivities of the coated glass were measured as a function of wavelength, and indices of refraction of the films were determined. The indices of refraction of MgF_2 films deposited on glass kept at room-temperature were found to be the same as that of bulk material. A.

539.234 : 539.27

2777. On the molecular arrangement of some organic films. Y. FUJIKI. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 119–25 (*Dec.*, 1949).

Thin films of paraffin waxes were prepared on metal foils and plates, and their structural changes with temperature were examined by electron diffraction method. It was found that the crystalline state in the basal part of the film was maintained up to a certain definite temperature above its melting point. This temperature increased linearly with increase of the number of carbon atoms in paraffin molecule, but was different from "transition temperature" named by K. Tanaka, at which regularlity of molecular arrangement in the surface layer of the film was completely destroyed. It was also found that molecules in the surface layer of the film were maintained in quasi-crystalline state up to the temperature mentioned above (transition temperature of the second kind). It was inferred that this phenomenon occurred even in the surface layer of the molten paraffin wax in bulk from its cooling curve. Extremely thin films of paraffin wax and films of some other similar compounds were also examined. A.

539.26

2778. On a macro-structure of amorphous selenium. J. WEBER. *Z. Naturforsch.*, **8a**, 565–6 (*Sept.*, 1953) *In German.*

It is well known that amorphous Se can show a macro-structure. Photographs under a high magnification are shown, and although "macro-crystals" are apparently observed, the absence of patterns when examined by Cu $K\alpha$ X-rays, suggests that the material must be regarded as amorphous. C. A. HOGARTH

539.26

2779. Small-angle X-ray scattering and interparticle interference in rayons. A. N. J. HEYN. Letter in *Nature* [*London*] **172**, 1000–1 (*Nov.* 28, 1953).

A systematic study of fibres of two rayons, "Fortisan" (Celanese Corp.) and "Fiber G" (du Pont), was carried out with dry and partly water-

swollen fibres, and with fibres swollen beyond the water-swollen state. The intensity-scattering angle curves only show inflections or maxima when the fibres are partly water-swollen; none appear when the fibres are either dry or swollen beyond the water-swollen state. The shape and extent of the inflection varies with the degree of swelling and this is explained on the basis of inter-particle interference in the denser states of packing. Particle size can be calculated from the slope of the curve relating log (intensity) to (scattering angle).[2] For fibres swollen beyond the water-swollen state this curve is a straight line and particle sizes of 45·9 Å for "Fortisan" and 40·6 Å for "Fiber G" were obtained (i.e. diameter of the micro-crystalline cylinders). J. IBALL

539.26

2780. A contribution to the study of the hydration of polymorphic forms of cellulose. C. LEGRAND. *Ann. Phys.* [*Paris*] **8**, 863–908 (*Nov.–Dec.*, 1953) *In French.*

An investigation, by X-ray diffraction methods, of changes in the structure of cellulose during hydration. After a brief introduction giving the current views on the chemical nature and crystal structure of cellulose the experimental details are given in Pt 1. Monochromatic X-rays, produced by a curved crystal monochromator, are used exclusively and special cameras in which the temperature and humidity can be controlled are described. Pt 2 gives the results on (1) native cellulose, (2) mercerized cellulose, (3) cellulose III (obtained by treating native cellulose with liquid ammonia and characterized by the X-ray diffraction pattern), (4) cellulose IV (this designation is given to the form obtained when mercerized cellulose is heated in water or glycerine at above 200°C). Pt 3 describes an investigation of the space group of cellulose and it is concluded that the most probable group is $P2_1$. The changes which the unit cells of the various forms undergo with changes in hydration are described. It is suggested that, with a substance as complex as cellulose, X-ray diffraction studies of changes and transformations of the lattice are more likely to reveal the true structure than are studies of any individual static lattice. J. IBALL

539.26 : 539.4.016.2

2781. X-ray studies of polycrystalline metals deformed by rolling. III. The physical interpretation of the experimental results. P. GAY, P. B. HIRSCH AND A. KELLY. *Acta cryst.*, **7**, 41–9 (*Jan.*, 1954).

For Pt II, see Abstr. 2759 (1953). The experimental results are discussed in terms of dislocation mechanisms. A "foam" structure of particles is produced by the deformation. The particles are regions of low dislocation density separated by boundaries of high dislocation density. It is suggested that the particles are the regions between the slip bands and that misorientations occur at the slip bands. Satisfactory agreement is obtained between the observed particle sizes and minimum slip-band spacings. The dislocations producing curvature are distributed over considerable volumes of material around the slip bands. The formation of particles is thought to be a direct consequence of the production and locking of slip bands during the deformation. The boundaries are regarded as obstacles to slip and the strength of a metal is related to the stress concentration necessary to transmit slip from one particle to the next. Satisfactory agreement is found between theoretical values of strength calculated on this basis, using a method given by Frank, and the experimental values. The mechanisms of recovery and recrystallization are discussed in the light of the experimental evidence. The experimental results are found to be in agreement with those of other workers in this field, with the exception of those of Wood; it is shown that a critical examination of the latter data may resolve some of the discrepancies. Some suggestions for further researches in this field are made. A.

539.27

2782. An electron-optical study on the surface of glass. J. J. ANTAL AND A. H. WEBER. *Acta cryst.*, **7**, 122–6 (*Jan.*, 1954).

Electron-diffraction patterns have been obtained from the surface of glass after deposition of a thin film of bismuth (thickness < 10 Å) to reduce electrostatic charging. The bismuth film is made up of preferentially oriented aggregates which contribute in a recognizable manner to the diffracted intensity. In order to compute radial distribution functions an approximate method was used which combined microphotometer and visual methods for obtaining the dependent coherent scattering. The results indicate that the surface structure of water-washed soda-lime-silica glass is essentially that of the bulk material with a deficiency of alkali atoms in the topmost atom layers. A.

539.27 : 539.38

2783. Crystallographic slip in diamond. M. SEAL AND J. W. MENTER. Letter in *Phil. Mag.*, **44**, 1408–10 (*Dec.*, 1953).

A technique of electron-irradiation at glancing incidence followed by microscopic examination was used to reveal the surface features of polished diamond. In addition to polishing marks lines were observed attributable to slip, induced by polishing, on one set of {111} planes corresponding, if a [110] slip direction be assumed, to the planes of greatest resolved shear stress. A. D. LE CLAIRE

539.27 : 541.182.3

2784. Preparation of aerosols for electron microscopy. E. H. KALMUS. *J. appl. Phys.*, **25**, 87–9 (*Jan.*, 1954).

A technique is described whereby fall-out particles from dust clouds, commonly called aerosols, may be prepared for observation with the electron microscope. Specimens are collected by means of various types of precipitators on molecular filters which are made from cellulose esters. During the process of dissolving this material in acetone, the particles adhering to the filter are transferred to the formvar-coated specimen screens of the electron microscope. Losses are negligible, residual filter background is eliminated and particles are clearly visible for measuring. A.

539.27 : 541.182.3 : 531.717.1

2785. The measurement of size and concentration of airborne dusts with the electron microscope. J. CARTWRIGHT AND J. W. SKIDMORE. *Safety Mines Res. Establ. Res. Rep.*, *No.* 79, 31 *pp.* (*Sept.*, 1953).

The application of the electron microscope in the

determination of particle size distribution is discussed. Methods of precipitation must be modified to give representative samples on mounted specimen support films. Reference is made to a special form of thermal precipitator. The limitations of the optical determinations are discussed, and comparison between optical and electron microscope determinations given. In the region where magnifications overlap, agreement is not good for reasons which are discussed and are mainly concerned with lack of resolution of the optical microscope. M. E. HAINE

539.27 : 771.5

2786. The electron microscopy of photographic grains. Specimen preparation techniques and applications. F. A. HAMM AND J. J. COMER. *J. appl. Phys.*, **24,** 1495–513 (*Dec.*, 1953).

Several techniques are described, including two replica techniques. The most important specimens utilize the thin film of the silver-gelatin complex which exists as a tightly fitting skin around the photographic grains. This relatively inert and insoluble complex is referred to as the combined envelope; a study of this structure is given. Latent image centres are enlarged in several ways so as to be readily resolvable in the electron microscope. After this partial development the matrix or intergrain gelatin is removed and the grains are fixed. The final specimen consists of developed centres retained by the combined envelope. Applications of the replica technique to grain shape, size distribution and growth nature of photolytic silver are given. Utilization of the combined envelope in conjunction with the special development techniques to provide information which substantiates independent sensitometric data is also demonstrated. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32

2787. An accurate determination of the torsion constant of quartz fibres used in the measurement of the magnetic anisotropy of crystals. S. K. DATTA. *Indian J. Phys.*, **27,** 155–66 (*March*, 1953).

The torsional oscillations of circular disks with suspensions of quartz fibre were studied for the determination of the torsion constant of the fibre. The correction of the time period for the damping of oscillations is found to be generally very small. The damping force is proportional to the first power of the angular velocity for small values of velocity, but to a higher power of velocity when it is large. The damping factor is found to be practically constant for the former case, dependent only on the dimensions of the vibrator and the factors affecting the viscosity of air. The effects of pressure, boundary conditions, etc., are also studied. A.

539.32

2788. Germanium under ultrasonic stress. I. Anelastic effects. G. S. BAKER, L. M. SLIFKIN AND J. W. MARX. Letter in *J. appl. Phys.*, **24,** 1331 (*Oct.*, 1953).

Pronounced anomalies are observed in the variation with temperature of Young's modulus and of the internal friction of single-crystal Ge (30 ohm.cm). The anomalies may be due to the motion of free dislocations. It is pointed out that normally active impurities in Ge may escape detection by conduction measurements if they lie at dislocation sites.

C. A. HOGARTH

539.32

2789. Germanium under ultrasonic stress. II. Dynamic yield point. G. S. BAKER, L. M. SLIFKIN AND J. W. MARX. Letter in *J. appl. Phys.*, **24,** 1331–2 (*Oct.*, 1953).

The piezoelectric driver-gauge method was used to produce vibrational strains and the effect of these cyclic loads on the internal friction and the effective elastic moduli of germanium is investigated. Above 500° there is a dynamic yield point for the larger strains and the ultimate values are 1·10, 0·78 and 0·52 kg.mm^{-2} for temperatures of 523, 560 and 614°c.

C. A. HOGARTH

539.32 : 534.21

2790. The determination of the elastic constants of isotropic rigid bodies by ultrasound. E. LEDINEGG AND P. URBAN. *Acta phys. Austriaca*, **8,** *No.* 1, 16–27 (1953) *In German.*

This is a theoretical paper giving the equations for determining the elastic constants of an isotropic body from measurements of the resonant frequencies for propagation of ultrasound in the body. A two-layer cavity resonator is employed consisting of a cylindrical resonator with test specimens in the form of rods or plates and the elastic constants are determined from measurements on both horizontal and axial layers. Approximate formulae are deduced for very thin rods and plates and found to agree with those obtained in earlier work. A. C. WHIFFIN

539.32 : 534.372

2791. A method for the measurement of dynamic mechanical properties of small samples of plastic material. W. P. VAN OORT. *Trans Instrum. Meas. Conf.*, **1952,** 267–76.

A method is described for determining the damping and dynamic modulus of elasticity at different frequencies, when only a few grams of a viscoelastic material are available. A steel strip, covered on one side or on both sides with a thin layer of the material under investigation, is simply supported at two points and set in transverse oscillation electrically; the variation of amplitude with frequency of the applied sinusoidal stress is then observed. The method is suitable for soft solids, and as little as 0·4 g may suffice for the determinations. J. G. OLDROYD

539.32 : 548.0 : 537.226.2

Elastic moduli of single crystals of ice. *See Abstr.* 2404

539.37

2792. Second-order elastic deformation of solids. D. S. HUGHES AND J. L. KELLY. *Phys. Rev.*, **92,** 1145–9 (*Dec.* 1, 1953).

Expressions for the velocities of elastic waves in stressed solids are derived using Murnaghan's theory of finite deformations and third-order terms in the energy. For isotropic materials, in addition to the

Lamé constants λ and μ, three additional constants, l, m and n, are required to describe the material. By measuring the transmission time of elastic pulses through the material, the velocities of longitudinal and shear waves are determined as a function of applied stress. By subjecting the material to hydrostatic pressure as well as simple compression, it is found that seven functions of the three constants l, m and n can be measured and thus numerical values calculated. Results are given for polystyrene, iron and Pyrex glass. A.

539.371

2793. Elastic deformation and the contact of surfaces. J. F. ARCHARD. Letter in *Nature* [*London*] **172,** 918–19 (*Nov.* 14, 1953).

A discussion, based on dimensional considerations, of the relation between the total area of real contact between two surfaces and the load when the deformation is assumed to be elastic. M. R. HOPKINS

539.373

2794. The effect of static and dynamic loading and temperature on the yield stress of iron and mild steel in compression. J. M. KRAFFT, A. M. SULLIVAN AND C. F. TIPPER. *Proc. Roy. Soc. A,* **221,** 114–27 (*Jan.* 7, 1954).

Cylindrical test samples were compressed statically and dynamically at temperatures ranging from +100 to −195°C and the yield stress, form of yield and surface markings observed. A Hopkinson bar and throw-off rod and electric resistance strain gauges were used for stress determinations under dynamic loads. The stress necessary to initiate yield rises steeply with fall in temperature and is accompanied by a change in mechanism of deformation from normal slip to the formation of Neumann lamellae at a critical temperature. The critical temperature is higher under dynamic loading, but there appears to be a critical stress for the formation of Neumann lamellae, whether caused by high rates of loading or low temperatures. A.

539.374

2795. Singular surfaces and flow lines in the theory of plasticity. T. Y. THOMAS. *J. Rational Mech. Anal.,* **2,** *No.* 2, 339 (1953).

The author discusses theoretically the markings which appear on the surfaces of solids that have been strained to the yield point assumed to originate as the curves of intersections of the surface of the body and singular surfaces separating distinct regions within the body. Two such singular surfaces appear to be of particular significance, namely, the slip surface and the W surface which involves a weakened form of the condition of slip. BRITISH SOCIETY OF RHEOLOGY

539.374 : 548.0 : 537.226.8

Plastic deformation of alkali halide crystals. *See Abstr.* 2411

539.42

2796. Dynamics of brittle tensile fractures of cylindrical glass rods. A. G. SMEKAL. *S.B. Österr. Akad. Wiss. IIa,* **161,** *No.* 9–10, 361–73 (1952) *In German.*

The mechanism of fracture is examined experimentally by using an ultrasonic pulse method which permits the initial stages (within a microsecond) to be followed. Results are given of the fracturing-velocity/time curves of quartz and Schott BK 7 glass rods under different tensile stresses. H. J. H. STARKS

539.62 : 531.717

An apparatus for recording surface friction and irregularity. *See Abstr.* 2053

539.67 : 534.372

2797. Experimental determination of the internal friction of wood. E. PTACNIK. *Acta phys. Austriaca,* **8,** *No.* 1, 28–34 (1953) *In German.*

Specimens of wood are vibrated in resonance between electromagnetic transducers attached to the ends and measurements are made of the resonant frequency and those giving an amplitude of vibration $1/\sqrt{2}$ of that at resonance. The damping coefficient is determined from these measurements, and, in general, increases with frequency to a small extent within the range up to 10 kc/s. For both transverse and longitudinal modes of vibration, the damping factor falls as the material is wetted and it increases with temperature. A. C. WHIFFIN

539.89

2798. Pressure chamber for micro-optical observations. C. TURNER. *J. sci. Instrum.,* **31,** 9–10 (*Jan.,* 1954).

A pressure chamber of small dimensions is described for optical observations at pressures up to 1000 atm. The apparatus has been tested for pressures up to 500 atm and for temperatures up to 100°C. It has been used for the measurement of latent heats of transition on small samples of materials. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.5 : 541.127

2799. Kinetic evidence for the gas-phase existence of the peroxy radicals NO_4 and NO_3. R. A. OGG, JR. Letter in *J. chem. Phys.,* **21,** 2079 (*Nov.,* 1953).

The main reaction in mixtures of highly O^{18}-enriched oxygen and N_2O_5 at comparable pressures of about 20 mm Hg and at 0° or 25°C proved to be an exchange of O^{18} with the N_2O_5. The data suggests a rate expression first-order in both N_2O_5 and O_2. The only plausible mechanism requires the formation of NO_3 and NO_4 as intermediates. It is suggested that NO_4 may be detected by infrared in high-pressure O_2–NO_2 mixtures. Provisional evidence for the existence of NO_3 is found in results on the isotopic exchanges accompanying the oxidation of NO by O^{18} enriched oxygen. H. H. GREENWOOD

541.123.5 : 541.128

2800. Ozone catalysis of isotope exchange between molecular oxygen species. R. A. OGG, JR AND W. T. SUTPHEN. Letter in *J. chem. Phys.,* **21,** 2078 (*Nov.,* 1953).

The extremely slow rate of attainment of the equilibrium $O^{16}O^{16} + O^{18}O^{18} \rightleftharpoons 2O^{16}O^{18}$ is increased

by O_3 catalysis (passage of an electric discharge through the O sample) so that the almost stationary mass-ratio product of ~ 100 falls after 10 min to ~ 6–10. The mechanism of the catalysis is suggested and discussed in some detail. F. LACHMAN

541.123.5 : 541.128

2801. Chlorine photosensitized isotope exchange between molecular oxygen species. R. A. OGG, JR. Letter in *J. chem. Phys.*, **21**, 2078–9 (*Nov.*, 1953).

O^{18}-enriched O with Cl addition, when exposed for a few hours to radiation from a Hg lamp, showed a decrease of the mass-ratio product ($O^{16}O^{16} + O^{18}O^{18} \rightleftharpoons 2O^{16}O^{18}$) from ~ 100 to ~ 30. The mechanism of catalysis by Cl photosensitization is suggested. F. LACHMAN

541.123.5 : 541.128

2802. The homomolecular exchange of oxygen. W. H. JOHNSTON AND C. J. O'SHEA. Letter in *J. chem. Phys.*, **21**, 2080 (*Nov.*, 1953).

The isotopic exchange reaction between identical molecules (homomolecular exchanges) has been studied with a sample of 25% O^{18} oxygen. No thermal exchange was observed at room temperature. A first-order exchange was observed with 2537 Å radiation in the presence of mercury vapour giving an exchange rate of $5{\cdot}6\times10^{13}$ sec^{-1} and an estimated quantum yield of 125 suggesting that the mechanism of exchange is the chain reaction initiated by the mercury-sensitized production of oxygen atoms.

H. H. GREENWOOD

541.124

2803. Quantum theory of polarographic reductions. A. PACAULT AND R. POINTEAU. *J. Chim. phys.*, **50**, 399–402 (*June*, 1953) *In French.*

Criticism of Coulson and Crowell's theory [*J. Amer. Chem. Soc.*, **74**, 1294 (1952)] of the polarographic reduction of polyenic aldehydes $CH_3(CH{=}CH)_jCHO$. It is claimed that other hypotheses, besides being more logical, give not less satisfactory results. The following formula is developed by the author: $E_{\frac{1}{2}}^0 = 4{\cdot}790 - 19{\cdot}06(j+2)^2/(2j+3{\cdot}506)^2$. F. LACHMAN

541.126

2804. Detonation in condensed explosives. J. TAYLOR. *Oxford: Clarendon Press* (1952) xi + 196 *pp.* [Monographs on The Physics and Chemistry of Materials.]

Review in *Nature* [*London*] **172**, 699 (*Oct.* 17, 1953).

541.127

2805. Investigation of the kinetics of the reaction between potassium persulphate and oxalic acid. S. P. SRIVASTAVA AND S. GHOSH. *Z. phys. Chem.*, **202**, 191–7 (*Oct.*, 1953).

The reaction is autocatalytic and the rate highly dependent on temperature, being measurable at temps. above 45°; it is catalysed by Ag^+, Cu^{++}, $HgCl_2$ and H_3O^+, but is slowed down by neutral electrolytes, this "salt effect" decreasing as the ionic strength increases. There is an induction period due partly to the increase in the conc. of H_2SO_4 formed in the reaction. S. J. GREGG

541.127

2806. Investigation of the kinetics of the reaction between potassium persulphate and potassium formate. S. P. SRIVASTAVA AND S. GHOSH. *Z. phys. Chem.*, **202**, 198–207 (*Oct.*, 1953).

The reaction is unimolecular both at high concentrations of formate ion (X) and at equivalent concentrations of $S_2O_8^{--}$ and of X; it proceeds at a measurable rate above 30°, is greatly dependent on temp., is catalysed by Ag^+ and Cu^{++} and is slowed down by neutral salts and by urea. The inhibiting effect of halide ions is in the order $I^- > Br^- > Cl^- \gg F^-$. A mechanism is proposed in which the rate-determining step is the reaction between the $S_2O_8^{--}$ ion and water. S. J. GREGG

541.127

2807. Note on the quantum-mechanical calculation of reaction rates. S. GOLDEN. Letter in *J. chem. Phys.*, **21**, 2071–2 (*Nov.*, 1953).

The quantum mechanical treatment of the reaction $H_2 + Br \rightarrow H + HBr$ by Bauer and Wu [Abstr. 4443 (1953)] is criticized by comparison with the author's treatment [Abstr. 6486 (1949); 2747 (1950)] which uses the Born approximation for rearrangement collisions. Several difficulties associated with the assumed linear model of Bauer and Wu are noted. There is the neglect of rotational motion and the problem of estimating the probability for a linear molecule. The perturbation matrix elements for the symmetrical potential and wave functions used may be expected to change appreciably by the introduction of some asymmetry appropriate to the problem. In particular certain matrix elements are no longer zero by symmetry. The steric factor calculated by Bauer and Wu may therefore be too large. The approximations used to simplify the translational matrix elements virtually eliminate the assumed interaction between bromine atom and hydrogen molecule. Furthermore transitions originating from excited states are neglected. It is concluded that the reasonable value obtained by Bauer and Wu for the steric factor may be fortuitous. H. H. GREENWOOD

541.127

2808. The quantum-mechanical calculation of reaction rates: a reply to the preceding note. E. BAUER AND T.-Y. WU. Letter in *J. chem. Phys.*, **21**, 2072 (*Nov.*, 1953).

See preceding abstract. The method used by Golden calculates the rate constant by perturbation theory between the initial and final states. It does not account directly for the existence of the activated state as a real state. The neglect of rotational motion criticized by Golden does not change the calculated probability fundamentally whilst the cross-sections for reactions originating from excited states are estimated to be of the same order of magnitude as those calculated and would therefore modify the cross-section by a factor of the order of 2. The use of an asymmetrical potential considered by Golden is just as arbitrary as the author's symmetrical potential. The cross-section calculated depends upon the nature of the transition and on the amount of energy transferred rather than the shape of the potential. In spite of the crude approximations made, the authors do not consider Golden's criticisms to be relevant to their method. H. H. GREENWOOD

541.127

2809. Formulation of the velocity constant in chemical kinetics. J. C. ROBB. Letter in *Nature* [*London*] **172,** 1055–6 (*Dec.* 5, 1953).

As it is doubtful for many reactions which of the various possible values should be taken for the rate constant, it is suggested here that this constant should be based on the intermediate complex formed and not on any of the reactants. This formulation is not ambiguous, and is specially useful for reactions involving the association of radicals. Some examples are discussed. A. J. TAYLOR

541.127 : 535.343 : 541.14

2810. Triplet states in solution. G. PORTER AND M. W. WINDSOR. Letter in *J. chem. Phys.*, **21,** 2088 (*Nov.*, 1953).

Using flash photolysis and spectroscopy techniques for aromatic hydrocarbons in solution a transient reduction in absorption due to the single state is observed accompanied by appearance of new transient absorption bands. These new bands are attributed to triplet levels and disappear in about 100 μsec after the photolysis flash. 50% conversion of molecules to the triplet state per flash can be obtained and the method provides a means of measuring the kinetics of triplet state reactions.

G. F. J. GARLICK

541.127 : 541.15

2811. The substitution reactions of halogens activated by neutron capture. Their energetic and electronic state in aromatic substitution. N. IVANOFF AND G. GAVORET. *J. Chim. phys.*, **50,** 524–6 (*Oct.*, 1953) *In French.*

The rates of substitution of Br^{82} in phenol, anisol, toluene, nitrobenzene and methyl and ethyl benzoates are compared with those of electrophilic, nucleophilic and neutral radicals in these compounds. The relative degree of substitution in the *o*-, *m*- and *p*-positions has also been determined. The behaviour of Br^{80}, I^{128} and Cl^{38} is briefly discussed and a theory is proposed to explain the different reaction velocities.

G. I. W. LLEWELYN

541.128 : 539.219

2812. On the lattice parameters and Curie points of unreduced iron catalysts. R. WESTRIK. Letter in *J. chem. Phys.*, **21,** 2094–5 (*Nov.*, 1953).

Determinations of lattice parameters and Curie points of singly promoted iron catalysts prepared according to a melting process and containing increasing amounts of Al_2O_3 (the bivalent/tervalent ions ratio being 0·5) have shown that the lattice parameter decreases linearly as the ratio $Al^{3+}/(Fe^{3+} + Al^{3+})$ increases and that the Curie point also markedly decreases as the amount of Al_2O_3 increases.

F. LACHMAN

ELECTROCHEMISTRY 541.13

541.13 : 534.39

2813. Effect of ultrasonics during anodic oxidation. J.-J. TRILLAT. *C.R. Acad. Sci.* [*Paris*] **237,** 1147–8 (*Nov.* 9, 1953) *In French.*

It has been found that, when an Al foil vibrates at ultrasonic frequencies during a process of anodic oxidation, the structure and properties of the Al_2O_3 layer formed differ markedly from those of a layer formed without ultrasonics. F. LACHMAN

541.13 : 536.7

2814. Thermodynamics of transport processes in ion mixtures and application to isotope-containing salts and metals. A. KLEMM. *Z. Naturforsch.*, **8a,** 397–400 (*July*, 1953) *In German.*

The expression, $K_i = \sum_k r_{ik} v_k (w_i - w_k)$, $r_{ik} = r_{ki}$ ($K_i = -\text{grad}\ \mu_i$, $\bar{\mu}_i$ = electrochemical potential, v = mol fraction, w_i = average translation velocity of the component i), derived from the thermodynamics of irreversible processes, is used to determine the conductivity x, the self diffusion constants D^+ and D^-, and also the mass effect of the electrolytic cation and anion migration μ^+ and μ^-, as functions of the coefficient of friction r_{ik}. From isotope separation experiments, it follows that the friction in salts due to the movement of two isotopic species of cation is greater than that of the total movement of the cations against the anions. Quantitatively, $z^- r^{++}/z^+ r^{+-} = 2 \cdot 3$, where z^+ and z^- are the valencies of the cations and anions. H. H. HODGSON

541.132 : 532.74

X-ray diffraction and electrolytic dissociation. *See Abstr.* 2087

541.135

2815. On the calculation of the activity-coefficient. M. DUTTA. Note in *Naturwissenschaften*, **40,** *No.* 18, 481 (1953).

M. Dutta and S. N. Bagchi [Abstr. 7559 (1950)] have proposed a distribution formula for electrolytes in solution, which Bagchi [Abstr. 9116 (1952)] has used with modification for finite molecular size. The present note gives the modified formula in a form free from a fundamental objection which applied to the form used by Bagchi. A. J. TAYLOR

541.135

2816. Self-diffusion of thallium in fused thallium chloride. E. BERNE AND A. KLEMM. *Z. Naturforsch.*, **8a,** 400–3 (*July*, 1953) *In German.*

The capillary method is employed to measure the self-diffusion D^+ of labelled Tl^{204} in fused TlCl at temperatures between 487°C and 577°C. The result is: $D^+ = 76 \times 10^{-5} \exp(-4600/RT)$, where D^+ is in $cm.^2 sec^{-1}$ and R in cal. mol^{-1} $grad^{-1}$. By comparison with the electrical conductivity and with the mass effect of the electrical cation migration, it follows that, on electrolysis, the force effect of the electrical field on the components Tl and Cl is not given by the product, 1 Faraday × field strength, but is smaller by the factor 0·32. Experimental details for the preparations and capillary measurements are included, with diagram of apparatus.

H. H. HODGSON

541.135 : 537.528

Characteristics of the anodic spark in spark electrolysis. *See Abstr.* 2461

541.135.4

2817. Contribution to the study of the diffusion of metallic ions through electrolytic metallic coatings. H. MAKRAM. *C.R. Acad. Sci.* [*Paris*] **237,** 1086–8 (*Nov.* 2, 1953) *In French.*

Previously [Abstr. 1215 (1953)] a method was de-

scribed for the study of labelled Cu ions through electrolytic Cr coatings. Data are now reported relating to the variation of the time of passage T as a function of the composition of the Cr coating bath, especially with respect to the content of $SO_4^=$ anions. For this purpose a bath containing 250 g/l CrO_3 was treated with increasing amounts of Na_2SO_4 and curves are given for various bath compositions, from which $\ln T = f(e)$, where e is the coating thickness. The addition of SO_4 initially causes a diminution of the slope of the T composition curve, followed by a rise to a maximum at 40 g/l Na_2SO_4 and then a fall. The results are discussed from the standpoint of the porosity of the coatings. H. H. HODGSON

541.135.5

2818. Limiting conditions in the calculation of diffusion currents to dropping electrodes. W. HANS AND W. HENNE. Note in *Naturwissenschaften*, **40**, *No.* 20, 524 (1953) *In German.*

A brief note dealing with current-time effects with mercury dropping electrodes. J. D. CRAGGS

541.135.5

2819. Metal overvoltage measurements at cadmium. W. LORENZ. Note in *Naturwissenschaften*, **40**, *No.* 22, 578 (1953) *In German.*

Overvoltage data are determined for Cd by means of the electrolytic separation-dissolution method, disturbances at the metallic electrode surface being measured by the oscillograph. The Cd is precipitated from a neutral aqueous 2N . $CdSO_4$ (or $CdSO_4 + K_2SO_4$) solution at 20–80 mA/cm² on Pt electrodes. Experimental details are given and the data discussed. Similar results are afforded by $Cu(NO_3)_2$ solutions. 7 refs. H. H. HODGSON

541.135.5

2820. Electrolytic polishing of germanium and platinum in presence of the ions F^- or Cl^-. P. BROUILLET AND I. EPELBOIN. *C.R. Acad. Sci.* [*Paris*] **237**, 895–7 (*Oct.* 19, 1953) *In French.*

Germanium and platinum, which normally are difficult metals to polish, are electrolytically polished to a high degree of efficiency in fused mixtures of KCl (48 mole %)—NaCl of fusion point 661°c, and in the eutectic KF (60 mole %)—NaF of fusion point 699°c. Similar results are obtained with gold, palladium and several of their alloys.

H. H. HODGSON

541.135.5

2821. Measurement of electrode polarization by the current-interrupter method. S. BARNARTT. Letter in *J. chem. Phys.*, **21**, 2090 (*Nov.*, 1953).

From a map of the equipotential lines in the electrolyte around a disk electrode over which the potential varies linearly with radius from centre to edge, it is shown that for accurate polarization measurements by the current-interrupter method, an electrode should be used over which the current density is uniform. H. H. HODGSON

541.135.6

2822. The problem of the limiting anodic current for lattice structure polarization. W. LORENZ. Note in *Naturwissenschaften*, **40**, *No.* 22, 576–7 (1953) *In German.*

The influence of the crystalline structure of an electrode surface on polarization is illustrated by 5 c.d.-potential curves and interpreted as a metal concentration polarization. 5 refs. H. H. HODGSON

541.138.2

2823. Influence of oxygen and of surface coatings on the electrochemical corrosion of lead and on its cathodic protection. R. HORNUNG. *Tech. Mitt PTT*, **31**, *No.* 10, 265–88; *No.* 11, 318–41 (1953) *In German.*

A review of the whole subject of electrolytic corrosion is followed by a description of experiments with the corrosion element Pb/Pt and with a polarization cell. In O_2 containing chloride or carbonate solution, the Pb is slowly coated with a corrosion product, the potential becomes more positive and the coating arrests the corrosion. This protective action, however, is destroyed by the current in the corrosion element which is uninfluenced by the Pb coating. The local current corrosion of uncoated Pb corresponds approximately to O_2 diffusion at the Pb electrode. The latter is strongly corroded when combined with a much greater Pt electrode. Appreciable anodic polarization only occurs when the Pb is very strongly coated. In standard acetate solution (pH 4·6) containing O_2 but Pb free, the Pb electrode is heavily corroded at $-0{\cdot}3$ V against the normal H_2-electrode. The critical c.d. is equivalent to the expected O_2 diffusion at the electrode. Suggestions for cathodic protection of Pb are made. 116 refs.

H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

2824. Mechanism of the Hg ($^3P_1$) photosensitized decomposition of ethylene. A. G. MITCHELL AND D. J. LE ROY. Letter in *J. chem. Phys.*, **21**, 2075–6 (*Nov.*, 1953).

The reaction has been studied using a resonance lamp as light source giving an emission line much narrower than that of the l.p. arc used hitherto. The absorption from a l.p. arc by mercury vapour becomes increased in the presence of ethylene due to pressure broadening. In consequence the rate $v.$ (C_2H_4) curve is distorted and the maximum is shifted towards higher ethylene pressures. These effects are absent when the emission line of the resonance lamp is narrow compared with the absorption line. The maximum then occurs at 2 mm ethylene pressure compared with the broad maximum centred at 9 mm for the l.p. arc source. Darwent's earlier explanation of this large value in terms of the quenching of ($^3P_1$) atoms to ($^3P_0$) by ethylene is therefore not borne out. The shape of the rate $v.$ (C_2H_4) curve suggests that deactivation rather than decomposition of the excited C_2H_4 may take place at the walls. H. H. GREENWOOD

541.14

2825. Remarks on mechanism of the Hg ($^3P_1$) photosensitized decomposition of ethylene. B. DEB. DARWENT. Letter in *J. chem. Phys.*, **21**, 2076 (*Nov.*, 1953).

See preceding abstract. The arguments of Mitchell and Le Roy are in general accepted. Further detailed

mplications of their experimental results are uggested. H. H. GREENWOOD

541.14

2826. Reaction of optically excited mercury vapor with oxygen. D. H. VOLMAN. Letter in *J. chem. Phys.*, **21**, 2086 (*Nov.*, 1953).

The formation of ozone was investigated: oxygen at normal pressure and Hg at 0·0013 mm were irradiated in a flowing system with light of which the range with wavelength less than 2500 Å was extinguished. It was found that every Hg atom entering the zone caused about 40 molecules of O_3 to be formed. This is much more than could originate from the reaction $Hg + O_2 \rightarrow HgO + O$, as was formerly supposed. Further experiments are being carried out. A. J. TAYLOR

541.14 : 539.132

2827. The photochemical decomposition of nitric oxide by absorption in the (0, 0) and (1, 0) γ-bands. G. E. MOORE, O. R. WULF AND R. M. BADGER. Letter in *J. chem. Phys.*, **21**, 2091–2 (*Nov.*, 1953).

Irradiation of NO by a Cd spark, with NaCl filter to absorb below 2050 Å, led to formation of N_2O_3 which was detected by its continuous absorption. If this were shown to be due to predissociation it would establish the lower values for the dissociation energies of NO and N_2. A. G. GAYDON

541.15

2828. Transfer agents and chemical protection against ionizing radiations. A. PRÉVOT-BERNAS. Letter in *J. Chim. phys.*, **50**, 445–6 (*July–Aug.*, 1953) *In French.*

Cysteine, which is a powerful transfer agent, exhibits a marked protection effect in the radiation-induced polymerization of acrylonitrile. Thiourea, less powerful as a transfer agent, is less effective in protection. C. B. ALLSOPP

541.15

2829. Action of gamma rays on aqueous solutions of ferrine, ferroine and ortho-phenanthroline. After-effect. M. LEFORT AND J. PUCHEAULT. *J. Chim. phys.*, **50**, 580–6 (*Oct.*, 1953) *In French.*

Two effects can be distinguished when solutions of ferric ortho-phenanthroline (ferrine) are irradiated with γ-rays: reduction to ferroine and slow destruction of the complex. The first of these is the more important: it has a high yield, and continues after the end of the irradiation. This after-effect only occurs in the presence of air and is attributed to oxidation of ortho-phenanthroline by the γ-rays to form a peroxide which is capable of slowly reducing the ferrine. C. B. ALLSOPP

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.182.025

2830. Thixotropy. J. PRYCE-JONES. *Kolloid Z.*, **129**, 96 (1952).

Thixotropy is discussed on the basis of the definition used by Freundlich and Peterfi. Gel-sol transformations are considered and defined by the presence or absence of a yield value. By means of a general diagram the degree of dispersion can be determined from rheological behaviour. BRITISH SOCIETY OF RHEOLOGY

541.182.3

2831. The growth and shrinkage of aerosols. V. K. LA MER AND S. COTSON. *Science*, **118**, 516–17 (*Oct.* 30, 1953).

Describes experiments in which monodisperse aerosols of dioctyl phthalate (DOP) grown over master solution of DOP and toluene were diminished in droplet size when placed in a vessel containing a master solution with a lower proportion of toluene. It has been found that the shrinkage, just as the growth, of these aerosols is an equilibrium process under the given experimental conditions. Attempts at ascertaining, with H_2SO_4, and glycerol, aerosols, whether or not the presence of surface film on the aerosol has any effect on the rate of shrinkage have failed to give results because of the impossibility of obtaining monodisperse sols with these substances. F. LACHMAN

541.183

2832. The physical chemistry of surface films. W. D. HARKINS. *New York: Reinhold; London: Chapman and Hall* (1952) xvi + 413 *pp.*

Review in *Proc. Phys. Soc.* [*London*] *B*, **66**, 1126 (*Dec.*, 1953).

541.183

2833. Measurement of rates of adsorption. R. A. W. HAUL AND F. R. L. SCHÖNING. Note in *Naturwissenschaften*, **40**, *No.* 19, 507 (1953) *In German.*

An equation is given for calculation of the rate of diffusion of adsorbed molecules in porous substances, from results of the fall in pressure with time in a constant volume apparatus. S. J. GREGG

541.183 : 541.135

2834. Adsorption isotherms in the formation of electrolytic deposits of protactinium on gold. C. FERRADINI. Letter in *J. Chim. phys.*, **50**, 589–90 (*Oct.*, 1953) *In French.*

Pa^{231} indicated with Pa^{233} was electrolytically deposited on gold (held at a constant potential 0·05 V below the calc. equilibrium potential) from solutions varying between $1{\cdot}8\times10^{-12}$ and $3{\cdot}2\times10^{-7}$ M. The β-activity was used to determine the concentration of Pa deposited (x_d) and in solution (x_s). x_d corresponded to 3×10^{-5} to 4 monolayers. Log x_d plotted against log x_s gave two straight lines (corresponding to two Freundlich isotherms) intersecting at 0·2 of a monolayer. The first is believed to correspond to adsorption on active centres and the second to mutual interaction of the adsorbed Pa atoms [see also Haissinsky and Danon, *J. Chim. phys.*, **49**, C 123 (1952)]. S. J. GREGG

CHEMICAL STRUCTURE 541.2/.6

541.5 : 548

2835. Valence stabilization in crystals. D. M. GRUEN. Letter in *J. chem. Phys.*, **21**, 2083 (*Nov.*, 1953).

Proposes a theoretical model, involving Zener's double exchange mechanism, to explain the pheno-

menon of "valence inductivity," the stabilization of certain valency states of multiple-valency cations in solid solutions with fixed-valency cations. The model is exemplified by results of measurements on Pr_2O_3–La_2O_3. E. P. WOHLFARTH

541.5 : 548.7

2836. On the bonding state in Ru_3Sn_7 type crystals. K. SCHUBERT. Note in *Z. Naturforsch.*, **8a**, 450–1 (*July*, 1953) *In German.*

The structure of Ru_3Sn_7 and related compounds is interpreted in terms of an electron lattice with ordered spins, requiring ideally 54 electrons per molecule. A comparison with $RuSn_2$ leads to the conclusion that one element in a single alloy system may have different effective valencies. W. M. LOMER

541.54 : 539.132

2837. Madelung constants and coordination. D. H. TEMPLETON. Letter in *J. chem. Phys.*, **21**, 2097–8 (*Nov.*, 1953).

For binary crystals an empirical relation is found between the Madelung constant A and the co-ordination numbers of the ions. A plot of α, the Madelung constant per valence bond, against $1/m$ shows a linear relationship; m being a weighted harmonic mean of co-ordination numbers for cations and anions. J. JACOBS

541.65/.68 : 548.0

2838. The influence of water molecules on the physical properties of crystalline hydrates. W. A. WOOSTER. *J. Chim. phys.*, **50**, C 19–C 25 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. A discussion of the influence on the thermal expansion, piezo- and ferro-electricity, elasticity, dielectric and optical properties and hardness, with quantitative relations for some compounds. C. TURNER

541.67

2839. On the preparation and the magnetic susceptibility of the alcanoates of divalent cobalt. C. MOREAU AND M. VATTERONI. *C.R. Acad. Sci.* [*Paris*] **237**, 1090–1 (*Nov.* 2, 1953) *In French.*

The magnetochemistry of the compounds $[H(CH_2)_nCO_2]_2Co$ for values of n between zero and 17 indicates that, in the anhydrous solid state, these substances should have a complex structure. By correcting for the diamagnetism of the organic portion of the molecule, a value of χCo^{++} is deduced from each observed susceptibility. G. I. W. LLEWELYN

CHEMICAL ANALYSIS 543/545

545.8 : 536.424

2840. On the quantitative differential thermal analysis of powder containing quartz. O. PREINING, J. A. SCHEDLING AND J. B. WEIN. *Acta phys. Austriaca*, **8**, *No.* 1, 89–96 (1953) *In German.*

The apparatus used by Schedling [*Staub*, Pt 27 (1951); *Ber. Deutsch. Keram. Gesellsch.*, **30**, Pt 1 (1953)] is shown schematically. The substance under investigation is compared with another inert substance which is free from transformation in the experimental temperature range. A series of calibration measurements is described. The response is linearly related to the amount of quartz present. S. WEINTROUB

545.822

2841. Phosphorus in steel. K. C. MAZUMDER AND M. K. GHOSH. *Indian J. Phys.*, **27**, 11–16 (*Jan.*, 1953).

Using a medium quartz spectrograph and a 20 kVA transformer lines of phosphorus in steel were photographed and the content evaluated. The accuracy was fairly good. It is suggested that the inaccurate ones were due to segregation. A.

545.822

2842. A contribution to the spectrochemical analysis of boron. M. MITROVIĆ. *Recueil Trav. Inst. Rech. Struct. Matière* [*Belgrade*] **2**, 23–6 (*Jan.*, 1953).

Green bands of BO were sensitive but quantitively unreliable. The B doublet at $\lambda 2497$ was used. A condensed spark (8000 V, 0·015 mH, 0·05 μF) between C electrodes and a d.c. arc (220 V, 8 A) gave sensitivities of 3×10^{-7} and 3×10^{-8} g respectively for aqueous solutions. For pellets of moistened solid pressed into hollowed C electrodes sensitivities were 1×10^{-6} and 1×10^{-7} g. A. G. GAYDON

545.822

2843. The use of sodium fluoride as carrier in the spectrographic determination of cadmium and boron in uranium. N. BELEGIŠANIN. *Recueil Trav. Inst. Rech. Struct. Matière* [*Belgrade*] **2**, 27–30 (*Jan.*, 1953).

Method of Scribner and Mullin [*J. Res. Nat. Bur. Stand.*, **37**, 579 (1946)] is modified. About 100 mg of sample is converted to U_3O_8 by heating nitrate and 10–15 mg NaF is added. This suppresses spectrum of U and assists distillation of trace elements. A carbon arc (70 V, 6 A) with Foster electrodes is used. Be is used as internal standard for Cd. For B either In or Be may be used. Sensitivity is 1×10^{-8} g B and 3×10^{-8} g Cd in 100 mg U_3O_8. Accuracy about 15%. A. G. GAYDON

545.822

2844. Quantitative spectrochemical analysis with the aid of a slitless spectrograph. A. CORNU. *Cahiers de Phys.*, *No.* 45, 1–28 (*Sept.*, 1953) *In French.*

For previous part, see Abstr. 249 (1954). The suggested method of analysis is described in detail. Two juxtaposed spectra are obtained from two sources fed by one Feussner generator, one of the sources using a standard alloy electrode; the distance of one source is then altered until the intensities of one of the lines in the two spectra become equal. The intensity/distance inverse-square relationship has been checked. The spark-gap used has been found to work satisfactorily. The method of obtaining alloy standards is described in detail. The constancy in time of spectral lines obtained has been studied. The analysis is described of a series of Cu–Zn alloy standards. F. LACHMAN

545.827

2845. Measurement of deuterium concentrations with the aid of a mass spectrometer. N. DOGRAMADŽI. *Recueil Trav. Inst. Rech. Struct. Matière* [*Belgrade*] **2**, 17–20 (*Jan.*, 1953) *In French.*

An attempt at determining the concentration of D

the form of methane in the concentration range 0·275–0·054 mol-%D with the aid of a mass spectrometer for a wide mass range. The peak 17 is assumed to be due to $C^{12}H_3D^+$ and $C^{13}H_4^+$, and the much more intense peak 16 to $C^{12}H_4^+$ and $C^{13}H_3^+$. A linear approximate equation is obtained for the relationship between the peak intensity ratio and the intensity ratio of the C^{12} methanes. The error in calculated values for the concentration 0·274 mol-%D is 2% of the true measured value. The spectrometer used was the 90°-deviation, Nier type spectrometer.

F. LACHMAN

545.827

2846. Detection by mass-spectrometry of free radicals formed in heterogeneous reactions. P. Le Goff. *J. Chim. phys.*, **50**, 423–5 (*June*, 1953) *In French.*

$Pb(CH_3)_4$, CH_3I and tertiary dibutyl peroxide were decomposed on hot W, Pt and Ni metal strips. The apparatus used is described and the theory of the possible chain of reactions is developed. The method suggested makes it possible to (1) investigate the kinetics of heterogeneous decomposition and recombination, (2) detect (and sometimes determine quantitatively) the free radicals formed, and (3) to study the mass spectrum of free radicals. The rates of decomposition have been found to be almost independent of the nature of strip metal; the true reactive surfaces are the same for the 3 metals; the CH_3 radicals have been found in considerable concentration, but no C_2H_6, CH_4 or C_2H_4. The ionization potential of CH_3 has been measured to be $I(15^+)_{15} = 9·85 \pm 0·2$ V.

F. LACHMAN

545.827

2847. Isotopic analysis of lead with the aid of a mass spectrometer. I. Preparation of tetramethyl-lead. G. Ducheylard, B. Lazard and E. Roth. *J. Chim. phys.*, **50**, 497–500 (*Oct.*, 1953) *In French.*

Describes an adaptation of a classical method for a simple and rapid production of a few mg of $Pb(CH_3)_4$. Discusses the conditions of maximum yield and evaluates the upper possible limit of the fractionation of Pb isotopes during preparation.

F. LACHMAN

545.827 : 539.16.08

2848. On the employment of liquid emulsion in the titration of uranium from radioactive minerals. F. A. G. A. Brandão, E. Frota-Pessoa, N. Margem and W. Perez. *An. Acad. Brasil. Ciênc.*, **25**, *No.* 2, 99–106 (1953).

A detailed description of the method consisting in comparing the number of α-particle tracks obtained in an emulsion mixed with the solution tested, with that containing a standard solution prepared under analogous conditions. The merits of the method are discussed.

F. LACHMAN

545.827 : 539.172.4

2849. Boron detection in tissues using the (n, α) reaction. G. Mayr, H. D. Bruner and M. Brucer. *Nucleonics*, **11**, 21–5 (*Oct.*, 1953).

The distribution of administered B^{10} in tissues, at concentrations below the limit of chemical detection, was determined by an autoradiographic method. Layers of tissue in contact with the photographic emulsion were irradiated by thermal neutrons and the B^{10} distributions determined by observation of the resulting α-particle tracks.

L. R. SHEPHERD

545.84

2850. Periodic structures, rhythmic chromatograms, and radio-isotopes. H. Weil. *Atomics* [*London*] **4**, 286–91 (*Nov.*, 1953).

Mainly a historical review of the development of the idea of distinguishing between periodic structures and chromatograms. By periodic structures are meant parallel bands or concentric rings of precipitates consisting of chemically identical material. They may occur because of variable size of the colloidal particles of the material. There are remarks on the etymological propriety of using the word "chromatogram" as an inclusive term. It is suggested that radioisotope tracer techniques may facilitate the resolution of relevant complex phenomena.

A. J. TAYLOR

545.84 : 539.16

2851. Automatic recording of chromatograms of radioactive elements. P. Bonet-Maury. *Bull. Soc. Chim. France*, **20**, 1066–7 (*Nov.–Dec.*, 1953) *In French.*

Describes the design and operation of an apparatus constructed at the Institut de Radium, Paris. The chromatogram is wound on to a drum driven by a synchronous motor, passing in front of a narrow slit in a Pb screen; a G.M. counter arranged behind the slit and shielded by a heavy Pb armour is connected with an integrating recorder.

F. LACHMAN

CRYSTALLOGRAPHY 548

548.0 : 512.9

2852. High-order matter tensors in symmetrical systems. R. Fieschi and F. G. Fumi. *Nuovo Cimento*, **10**, 865–82 (*July*, 1953).

The schemes of components of general fifth and sixth order tensors of polar and axial nature are derived for all the crystallographic groups by using the method of direct inspection for triclinic, monoclinic, rhombic, tetragonal and cubic groups and elementary group theory for trigonal and hexagonal groups.

A.

548.0 : 536.413

Isotope effect and thermal expansion coefficients of crystals. *See Abstr.* 2361

548.5

2853. Crystal growth and dislocations. A. R. Verma. *London: Butterworths Scientific Publications* (1953) 182 *pp.*

Review in *Phil. Mag.*, **45**, 106 (*Jan.*, 1954).

548.5 : 532.785

Solute concentration around growing crystal. *See Abstr.* 2088

548.574

2854. Slip lines, etchpits and corrosion-pits. A. H. ABDOU. Letter in *Phil. Mag.*, **45**, 105 (*Jan.*, 1954).

Rapid etching of deformed Zn single crystals in 20% chromic acid produces etchpit groups along slip lines, the crystal surface otherwise remaining clear.

J. FRANKS

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

2855. The physics of long-chain crystals. V. DANIEL. *Advances in Phys.*, **2**, 450–94 (*Oct.*, 1953).

A comprehensive review dealing with the properties of the normal long-chain paraffins and their derivatives, these having in common certain features of bonding, a variability of structure and a liability to order-disorder phenomena of different kinds. The ability of C to form at least two essentially homopolar bonds is responsible for the occurrence of long-chain molecules consisting mainly of C atoms. The properties of such bonds is discussed, in particular the rotations about single bonds which can occur readily and which give flexibility to the molecules. In the crystalline state the molecular chains are packed as straight rods in layers and are held together by van der Waals forces between CH_2 groups. The methods of determining and classifying the various ways in which the chain molecules are arranged in the layers are given and illustrated for a few cases. Many of the physical properties of long-chain crystals find a ready interpretation in terms of the characteristics of bonding and structure. Long-chain crystals are unusual in that numerous alternative structures of similar stability exist differing in minor details of packing of molecules and in the extent to which the bonding forces restrain the twisting and turning motion of long chains. The various experimental methods for investigating alternative structures and rotational disorder are described and accounts given of theoretical interpretations of the results obtained. The most successful theoretical approach has been the systematic correlation of thermodynamic information for different materials and structural forms. There is an account of work on the nature of the processes of melting of long-chain crystals, which is of particular interest because the packing of molecules in the liquid and solid state differs less in general than for other substances; and also of irregularities in structure, such as due to holes or to some molecules being "upside down" in the structures (structures containing such irregularities may be unstable but sufficiently long lived to be studied). The practical importance of these studies leads to an understanding of plastics.

A. D. LE CLAIRE

548.7 : 539.11

Introduction to solid state physics. *See Abstr.* 2626

548.7 : 539.11

2856. On the problem of transition between homopolar and ionic binding. T. NEUGEBAUER. Note in *Naturwissenschaften*, **40**, *No.* 17, 459–60 (1953) *In German.*

The question of which terms vanish, of an expansion into spherical functions of the potential in a crystal is discussed elsewhere [Abstr. 6310 (1953)]. Some examples are now given. The third spherical function does not vanish for zincblende, where each ion has four neighbours. For NaCl and CsCl the third function vanishes. For wurtzite all terms have a non-zero value, although the first two coefficients are small; this is caused by the non-symmetric tetrahedra. There is in these cases a considerable charge shift so that the valence electrons cannot be attributed to any special nucleus. In the series CuBr, ZnSe, GaAs and GeGe the ionic binding changes into homopolar binding, the ionic distances decreasing at the same time. The hardness of the compounds increases. Polarization energy is often responsible for the type of crystal, but van der Waals energy may also have influence.

A. J. TAYLOR

548.7 : 541.1

On the bonding state in Ru_3Sn_7 type crystals. *See Abstr.* 2836

548.7 : 539.219 : 539.2

2857. A thermal gradient method for the study of crystal structure and its application to order-disorder research. J. B. NEWKIRK. *Rev. sci. Instrum.*, **24**, 1116–21 (*Dec.*, 1953).

A new method has been developed for studying the effect of temperature on the crystal structure of metals and alloys. A long wire specimen is held for a desired period of time in a known thermal gradient and is subsequently quenched and examined at room temperature by X-ray diffraction. A special X-ray camera is used, by means of which any point along the length of the specimen can be irradiated. The diffracted rays are registered on a cylindrical film in the usual way. This technique offers substantial savings in treating time and has the advantage of subjecting the specimen to all temperatures within the range of treatment. The method has been applied to the study of ordering phenomena in several binary systems. Debye–Scherrer evidence for the existence of divariant equilibrium between ordered and disordered phases, has been found in several alloys of non-stoichiometric composition. A study of the copper-gold system has yielded data which allow the quantitative location of the (order + disorder) field boundaries near CuAu.

A

548.7

2858. The influence of symmetry on the general solution of one-dimensional disorder problems. H. JAGODZINSKI. *Acta cryst.*, **7**, 17–25 (*Jan.*, 1954) *In German.*

X-ray intensities of one-dimensionally disordered crystals are usually calculated by the method of difference equations or the equivalent matrix-method. In this paper a new group-theoretical method is developed, which has advantages in cases where the problem is one of pure disorder of positions, or of simultaneous disorder of kinds and positions of layers. A general demonstration is given that a strict solution for the diffracted intensities can be obtained with the aid of operators reducing the secular equation to a set of equations which can be solved independently, provided the symmetry-group is cyclic. Other groups admit solutions from their representation with cyclic

ctor-groups, or by separation into sub-groups. In e case of several kinds of tetragonal layers with ossibilities of (0, 0), ($\frac{1}{2}$, $\frac{1}{2}$), ($\frac{1}{2}$, 0) and (0, $\frac{1}{2}$) for their ositions, we find three independently soluble quations; for hexagonal layers with (0, 0), ($\frac{1}{3}$, $\frac{2}{3}$) and , $\frac{1}{3}$) as possible positions there are two equations. n both cases it is not necessary to introduce a pro- ibition of positions for neighbouring layers. The perators solving the secular equation may be used irectly for calculating the X-ray intensities. The onstants of the characteristic values may be calculated eparately for each equation. Each physically gnificant operator describes the intensity distribution n one kind of reciprocal-lattice row. A.

548.7

2859. Electronic energy bands in crystals. T. Vainwright and G. Parzen. *Phys. Rev.*, **92**, 129–34 (*Dec.* 1, 1953).

In a previous paper [Abstr. 2060 (1953)], a variational principle was derived for the energy levels of crystal. The variational principle was stated in erms of the Wannier functions of the crystal instead of the more usual Bloch waves. In this paper, the ariational principle has been applied to two problems, o the one-dimensional cosine potential, and to the nergy levels of the valence band of lithium. The nethod of forming the trial function is discussed. t was found more convenient to use the Wannier unction in momentum space rather than in con- iguration space. In the lithium case, the results are ompared with those obtained by the Wigner–Seitz pherical approximation. A.

548.7 : 537.311.33

Observation of cyclotron resonance in germanium rystals. *See Abstr.* 2432

548.7 : 537.311.33

The propagation of electrons in a strained metallic attice. *See Abstr.* 2433

548.7 : 539.217

2860. Surface migration of water molecules in ice. E. J. Murphy. *J chem. Phys.*, **21**, 1831–5 (*Oct.*, 1953).

This continues the discussion of data given in Abstr. 2245 (1952) on the second term in the "local conductivity" of ice. It is inferred that the H_2O molecules in internal surfaces are engaged in a special kind of random walk, in which the molecule is always attached to the surface by one chemical bond. This is described as bipedal random walk. It occurs with an activation energy of 5·2 kcal/mole (0·23 electron volt per molecule). On the other hand, molecules which jump up into field-free space and return to the surface have to acquire an energy of 11·5 kcal/mole (0·5 eV/molecule). The ratio of the corresponding Boltzmann factors is about 10^{-5} at 0°c and about 10^{-8} at −100°c; this implies that the dominant mode of diffusion in internal surfaces in ice is bipedal random walk. The migration of a water molecule on an ice surface is a special type of diffusion process. The general formulae of the theory of stochastic processes and diffusion become available for the description of the diffusion of water molecules in a surface if the appropriate expression for the diffusion constant D is substituted in the formulae. A new procedure is used to calculate D from the Einstein relation. Instead of using the direct-current conductivity, the second term of the local conductivity is used. The expression for the diffusion constant derived from the model for local conductivity is $D_L = 3{\cdot}5\times10^{-4}\exp(-5{\cdot}2\times10^3/\mathrm{RT})$ cm²/sec, where the activation energy $5{\cdot}2\times10^3$ cal/mole, is derived from the second term in the local conductivity of ice. This leads to a rather explicit model of the diffusion process: it may be described as bipedal random walk of the water molecule by the breaking of one bond at a time with an activation energy of 0·23 eV associated with each step. It is pointed out also that the water molecule on an internal surface has a polarizability characteristic of the surface structure. A.

548.7 : 539.155.4

2861. Absolute value of Avogadro's number and the soundness of crystals. M. E. Straumanis. *Phys. Rev.*, **92**, 1155–7 (*Dec.* 1, 1953).

The experimental determination of Avogadro's number by the X-ray-density method is uncertain because of imperfections in crystals. It is proposed to regard the lattice of purest calcite as a reference lattice because of its proximity to a sound lattice, and to accept the value $N_0 = 6{\cdot}02567\times10^{23}$ g mole^{-1} (phys.) which is equivalent to $6{\cdot}02403\times10^{23}$ g mole^{-1} (chem.) for Avogadro's number as derived from measurements on pure calcite. The perfection of the lattices of all other crystalline substances then would be determined in comparison with the calcite as either sound (equal in perfection to that of calcite) within the error limits or as defective (vacancies, interstitial atoms), using the number above for the calculations. A.

548.7

2862. Direct observations of dislocations in crystals. A. J. Forty. *Advances in Phys.*, **3**, 1–25 (*Jan.*, 1954).

A review of the current experimental evidence for dislocations in real crystals. Growth spirals may be centred on single dislocations, on small groups of like sign, or on "giant" ones with very large Burgers vector and a hole some microns in diameter along their axis. Polygonization and sub-grain boundaries are described and interpreted. The movement of dislocations may be inferred from certain complications in growth spirals, and from the movements of subgrain boundaries. Reasons are given for revising the usual estimate of dislocation density in annealed material to a figure of about 10^{-6} lines/cm². W. M. LOMER

548.7 : 537.311.31

2863. Lattice defects and the electrical resistivity of metals. T. Broom. *Advances in Phys.*, **3**, 26–83 (*Jan.*, 1954).

A review of the current theoretical and experimental situation. Recent calculations of the resistivity contributions of vacancies, interstitial atoms and dislocations and theoretical predictions of their mobilities are summarized. Experimental results and discussion of them are classified under the headings of quenching, irradiation and deformation experiments; the interpretation depends on the distinct (calculated) properties of the various defects. Many experiments and their interpretations are discussed in detail. 150 references. W. M. LOMER

548.7 : 539.169

Recovery rate after radiation damage. *See Abstr.* 2725

548.7 : 539.172.4 : 539.169

Radiation damage in insulators. *See Abstr.* 2726

548.7 : 535.37

2864. Thermal equilibrium between *F* centers and *M* centers in alkali halides. W. A. SMITH AND A. B. SCOTT. Letter in *J. chem. Phys.*, **21,** 2096 (*Nov.*, 1953).

548.7

2865. Variations in the texture of diamonds. F. C. CHAMPION. *Proc. Roy. Soc. A*, **220,** 485–97 (*Dec.* 22, 1953).

Various regions of several diamond specimens were explored with nuclear radiations of differing penetration. All the specimens showed some increase in the electric charge trap density towards the natural surface, but large differences occurred in the absolute magnitudes. Consideration of the present results and of others obtained by using different optical and electrical techniques leads to the conclusion that diamonds which show good electrical conduction pulse properties are composed of layers of highly perfect crystalline material separated by relatively few, and much thinner, partial barriers of imperfect material. If the average thickness of the crystallite layers is about 10 μ, then the specimen has the texture necessary for a good counter. The poorer counting shown by some specimens composed of still larger crystallites is attributed to the presence of wider barrier layers. See also Abstr. 2518 (1954). A.

548.7 : 535.343 : 538.222 : 538.569

2866. Study of molecules of water in solids by electromagnetic waves. *Paris: Centre National de la Recherche Scientifique, Colloque No.* 53 (1953) *In French.*

The articles are published in *J. Chim. phys.*; for abstracts see Abstr. 2285, 2289, 2293–4, 2302, 2321–6, 2399, 2401, 2404, 2407, 2838, 2867, 2894, 2901, 2908–10.

548.7 : 538.222

2867. The application of nuclear magnetic resonance to the structural study of crystals containing water molecules. G. E. PAKE. *J. Chim. phys.*, **50,** C 104–C 106 (*Sept.*, 1953) *In French.*

"Water molecules in solids," colloquium paper [see Abstr. 2866 (1954)]. A review of the method and results obtained, with special attention to the doubling arising from a term $KhI_{1z}I_{2z}$ indicating interaction between the protons through the intermediary of the electron spins. D. H. WHIFFEN

548.7 : 539.152.2

2868. Nuclear spin relaxation by translational diffusion. H. C. TORREY. *Phys. Rev.*, **92,** 962–9 (*Nov.* 15, 1953).

The general theory of Bloembergen, Purcell and Pound of nuclear spin relaxation has been extended to a more quantitative study of relaxation by translational diffusion. It has been found necessary to treat the problem by the theory of random walk. In the case of isotropic diffusion two cases have been studied: one in which the flight distance has a probability distribution, and the other in which it is constant. The problem of random walk to nearest neighbour sites in a lattice is also treated and quantitative results are obtained for a face-centred cubic lattice. A.

548.73/.74 : 539.26/.2

X-ray and electron investigation of materials. *See Abstr.* 2778–86

548.73

2869. Geiger-counter X-ray diffraction spectrometer: instrumentation and techniques. W. PARRISH AND E. A. HAMACHER. *Trans Instrum. Meas. Conf.*, **1952,** 95–105.

Describes the Norelco Geiger counter spectrometer. The points discussed are the basic design, the X-ray optics, the goniometer (2θ ranges from $-38°$ to $+165°$, with a reading accuracy of $0{\cdot}01°$), the counting and recording methods and the counter itself. A few applications are also mentioned. J. THEWLIS

548.73

2870. Accurate orientation of quartz oscillators with X-rays. W. PARRISH AND E. A. HAMACHER. *Trans. Instrum. Meas. Conf.*, **1952,** 106–12.

A description of the new Norelco instrument, with detailed discussions of techniques, accuracy, causes of error, speed and applications. L. PINCHERLE

548.73

2871. Low-temperature X-ray goniometer for structural studies of crystal transitions. R. KEELING, B. C. FRAZER AND R. PEPINSKY. *Rev. sci. Instrum.*, **24,** 1087–95 (*Dec.*, 1953).

A low-temperature X-ray goniometer for use between liquid nitrogen temperature and approximately $-100°$c has been designed for use with a Weissenberg camera, General Electric powder camera or a G.M. counter system. The crystal is mounted on a goniometer head inside a vertical cylindrical stainless steel dewar, and is irradiated through a polystyrene tip at the lower end of the dewar. The crystal is cooled by conduction through the goniometer head, which is silver-soldered to the base of a liquid nitrogen chamber inside and concentric with the outer wall of the dewar. The dewar vacuum is maintained by an oil diffusion pump and a fore pump, through a rotating seal and the post which supports the goniometer. The Weissenberg camera mounts on a carriage and is driven by a 60 r.p.m. reversing motor which also rotates the dewar and crystal. The carriage driving screws may be uncoupled from the motor shaft, and a G.M. counter spectrometer may be mounted on the carriage in place of the camera. The carriage is also adaptable for holding a GE powder camera. A General Electric CA-7 X-ray tube mounted horizonally supplies the X-ray beam. A.

548.733

2872. The recording of X-ray diffraction patterns on spheres. A. HERZOG AND D. MCLACHLAN, JR. *Amer. J. Phys.*, **22,** 33–6 (*Jan.*, 1954).

Since the theoretical treatment of X-ray diffraction is connected with spherical geometry spheres, the inside surface of some hollow glass spheres was coated with photographic emulsion and the diffraction of X-rays from small crystals located at their centres was recorded, as a teaching aid. A.

548.733

2873. Line interaction in X-ray and electron diffraction photographs. G. D. ARCHARD. *Brit. J. appl. Phys.*, **5**, 19–22 (*Jan.*, 1954).

The mutual effect of two neighbouring lines on X-ray and electron diffraction patterns is treated theoretically. The theory is in qualitative agreement with the experimental results of electron diffraction photographs (taken on plates) but cannot be used to correct these quantitatively on account of the practical difficulty of making the necessary measurements. In certain X-ray photographs (taken on films) there arises an effect, not treated by the theory, which for low values of Bragg angle acts in an opposite sense. The general conclusion is that for precision measurements close groups of lines should be treated with circumspection or altogether avoided. A.

548.733 : 537.531

2874. A small adjustable X-ray crystal monochromator. J. FORTEY AND E. COHEN. *J. sci. Instrum.*, **31**, 11–13 (*Jan.*, 1954).

Quantitative measurements of X-ray scattering patterns from glassy substances are much facilitated by using crystal reflected monochromatic radiation in place of the normally used mixture of continuous and characteristic radiations. A monochromator is described where compactness and simplicity in operation are claimed. The crystal is provided with the necessary degrees of freedom and the adjustment effected with the requisite accuracy. Parasitic and "white" radiations are suppressed and the strongest component of a multiply reflected beam can be easily selected. The instrument is not suitable for use with elastically bent focusing crystals. A.

548.734

2875. Focusing of X-rays with flat specimens. L. L. AMORÓS, J. M. CODINA AND J. M. SERRA. *An. Real Soc. Españ. Fís. Quim.*, **49(A)** 97–106 (*March–April*, 1953) *In Spanish.*

The use of flat specimens in a Seeman–Bohlin focusing camera is studied. The lines of the X-ray diagram are widened by the use of this technique, nevertheless the distal border of the lines coincides with the position of the theoretical line in a normal focusing camera. Formulae relating line width and camera constants are given and specifications of a suitable camera are stated. The camera is briefly described, and d *v.* mm formulae are given and generalized. A.

548.734

2876. Vertical divergence of the X-ray beam in a focusing camera with prepared plane. J. M. CODINA AND J. L. AMORÓS. *An. Real Soc. Españ. Fís. Quim.*, **49(A)** 269–73 (*Sept.–Oct.*, 1953) *In Spanish.*

The influence of the vertical divergence of the X-ray beam on the position of the distal border of the lines obtained by a focusing camera with a prepared plane has been studied with the help of formulae proposed by Eastabrook [Abstr. 541 (1953)]. In case of a point X-ray focus, the position of the distal border of the centre of the lines is not influenced by the vertical divergence. Therefore, from it can be directly deduced the value of the reticular distances as shown in preceding abstract. A.

548.734.3

2877. A direct graphical method for the determination of crystal powder diagrams. F. HUERTA AND I. ASENSIO. *An. Real Soc. Españ. Fís. Quim.*, **49(A)** 263–8 (*Sept.–Oct.*, 1953) *In Spanish.*

An equation curve is constructed $P = \log p = \log \lambda/2 - \log \sin \gamma/2$ with the notations p = crystal parameters, λ wavelength, $\gamma^0 = \gamma$ distance in millimetres from the rays to the middle of the diagram (a camera of a radius $R = 180/\pi = 57{\cdot}296$ mm has been taken) in which transferring the logarithm scale on the curve, the plane steps can be directly read. As this graph displaces values similar to the $\log N$, a nomogram is constructed with which the diagrams of the cubic system can be directly calculated and, from the quadratic ternary forms, the diagrams of any system. The reverse problem, namely, with a given diagram to calculate the indices of the parameters and rays, is directly and immediately solved in the case of the cubic system and is solved by computation in the other systems. A.

548.734.4

2878. Temperature diffuse scattering for cubic powder patterns. B. E. WARREN. Letter in *Acta cryst.*, 803 (*Oct.*, 1953).

Since determinations of short-range order depend on variations in the diffuse intensity a wrong expression for this intensity is to be avoided. In many cases the assumption of independent vibrations is inadequate and a better expression is given for powder patterns which takes account of the modulations in the diffuse background. J. THEWLIS

548.734.8

2879. The multiple-film technique: the effect of angle of incidence on the correlating factor. G. J. BULLEN. *Acta cryst.*, **6**, 825–6 (*Nov.*, 1953).

It is noted that the correlating factor for the multiple-film technique depends on the angle of incidence of the diffracted beam on the film and so has not the same value for all reflections. The variation of the factor is discussed in detail for oscillation photographs recorded on cylindrical films with the axis of the cylinder as the axis of rotation of the crystal, the factor being constant for all reflections on the same layer line. Methods of using spots on all layer lines, in an averaging process for finding the factor for each layer, are suggested. The treatment is also applicable to the method of interleaving films with metal foil when using Mo K radiation. A.

548.734.8

2880. The intensity measurement of small X-ray diffraction spots by projection of a positive print. D. EVANS AND S. WEISSMANN. *J. Opt. Soc. Amer.*, **43**, 1183–5 (*Dec.*, 1953).

The positive print method of measuring the integrated intensities of X-ray diffraction patterns has been combined with a projection and photometering apparatus. The time required for the intensity measurement of a single small spot is approximately 30 sec. The apparatus and typical results are described. A.

548.735

2881. Computing methods and the phase problem in X-ray crystal analysis. Edited by R. PEPINSKY. *Pennsylvania State College, X-ray Crystal Analysis Laboratory* (1952) ix + 390 *pp*.

Review in *Acta cryst.*, **6**, 875 (*Nov.*, 1953).

548.735

2882. A generalization of Garrido's method of interpreting Weissenberg diagrams. F. HUERTA. Note in *An. Real Soc. Españ. Fis. Quim.*, **48**(A) 109–10 (*March–April*, 1952) *In Spanish*.

A graphical method of constructing a layer of the reciprocal lattice is given. It can be adapted to the interpretation of de Sauter diagrams. A. R. STOKES

548.735

2883. Some remarks on the rôle of overlapping in the X-ray scattering by crystals. I. WALLER AND S. O. LUNDQVIST. *Ark. Fys.*, **7**, *Paper* 11, 121–4 (1953).

The structure amplitudes of LiH are calculated from the wave functions for the overlapping electrons. The calculation is probably only reliable for the ratio F_{111}/F_{200} and this value agrees with experiment. A. R. STOKES

548.735

2884. Some lattice indeterminacies. G. D. ARCHARD. *Acta cryst.*, **7**, 110–12 (*Jan.*, 1954).

Small departures of crystal lattices from high symmetry may be incapable of direct detection from powder patterns. It is shown, however, that the nature of small departures may be approximately gathered from a study of small discrepancies between the lattice constants deduced from different reflection planes. A.

548.735.4

2885. A new method of calculating the scale factor in structure analysis. G. KARTHA. *Acta cryst.*, **6**, 817–20 (*Nov.*, 1953).

A new method is suggested for obtaining the absolute structure factors from a set of relative intensities. It differs from the method of Wilson in that it does not depend on any statistical result. Formulae are obtained relating the sum of the intensities of all the reflections with certain integrals involving the electron-density distribution in the atoms. The method is applicable both to two- and three-dimensional data, but in practice it is more useful in the former case. The method makes use of the available structure-factor tables and has been verified to be valid in a number of cases where the scale factor is known. For the purpose of applying the method to unknown cases, tables of the required integrals are given for some of the commoner atoms which occur in organic crystals. A.

548.735.4

2886. The statistical theory of sign relationships. M. M. WOOLFSON. *Acta cryst.*, **7**, 61–4 (*Jan.*, 1954).

A statistical investigation of the relation between the signs of structure factors shows that the probability of the result $s(h)s(h') = s(h + h')$ is $Q/(1 + Q)$, where $Q = \exp(2\varepsilon^{-1}|U_h U_{h'} U_{h+h'}|)$ and $\varepsilon = \sum_{j=1}^{N} n_j$. These theoretical predictions are found to agree well with observation. A.

548.735.4 : 518

2887. Crystallographic calculations on the Manchester University Electronic Digital Computer (Mark II). F. R. AHMED AND D. W. J. CRUICKSHANK. *Acta cryst.*, **6**, 765–9 (*Oct.*, 1953).

The use of this computer for crystallographic calculations is described. Programmes have been devised for the calculation of structure factors, the computation of observed and calculated differential syntheses with solution for the co-ordinate changes and the estimation of errors. One cycle of the three-dimensional refinement process for a structure with 7 independent atoms and 667 structure factors can be carried out in about 1½ hr electronic computer time. A.

548.735.4

2888. Structure determination by the method of permutation syntheses. M. M. WOOLFSON. *Acta cryst.*, **7**, 65–7 (*Jan.*, 1954).

A trial-and-error method is described for finding the signs of the structure factors of a crystal. A standard set of sixteen combinations of seven signs is given, one of which is bound to have not more than one wrong sign. Syntheses, corresponding to these sign combinations for seven structure factors are produced photographically on film, making use of Huggins masks. Superimposing the partial syntheses for different groups of seven structure factors simulates the production of syntheses for all the structure factors together. Expected features of the structure are looked for in the resultant composite syntheses. The application of the method to the *h*0*l* projection of fluorene is described. A.

548.735.4

2889. The Fourier inversion of diffraction data. J. WASER AND V. SCHOMAKER. *Rev. mod. Phys.*, **25**, 671–90 (*July*, 1953).

A review, mainly concerned with the use of modification functions, i.e. factors by which the observed intensity functions are multiplied before Fourier inversion. These functions arise from the intensity cut-off, the existence of atomic scattering factors and temperature factors and a generalized complete modification function may be deduced. The one-dimensional electron diffraction pattern of a gas is used as an illustration and consideration is then given to X-ray diffraction by liquids and amorphous solids. Finally, the application of modification functions to the analysis of crystal structures is discussed.

J. THEWLIS

548.735.44

2890. Refinement of a non-centrosymmetrical structure: sodium nitrite. M. R. TRUTER. *Acta cryst.*, **7**, 73–7 (*Jan.*, 1954).

In a re-determination of the structure of sodium nitrite it was found necessary to use the "modified Fourier method" for accurate refinement and for calculation of the standard deviation. The factors limiting the accuracy possible in the determination of this type of structure were examined, particularly the effect of variations in the scattering factors on the atomic parameters and the agreement index. The accuracy attainable was lower than that expected for

structure with few parameters and indicated the importance of investigating all the assumptions made in the refinement of a crystal-structure determination. The dimensions obtained for the nitrite ion were: N–O bond length 1·24(7) ± 0·035 Å and O–N–O angle 114·2 ± 4°, the limits being the standard deviations. A.

548.735.46

2891. On "partial" Patterson diagrams: application to the structure of NiSi. L. Brú, M. P. Rodríguez and V. Cortés. Note in *An. Real Soc. Españ. Fis. Quim.*, **48(A)** 187–8 (*May–June*, 1952) *In Spanish.*

Describes the use of a synthesis giving the difference between the Patterson function for the whole structure and that for the heavy atoms alone. A. R. STOKES

548.735.46

2892. A modification of R-PAC for interpretation of Patterson maps in X-ray crystal analysis. R. Pepinsky. Letter in *J. appl. Phys.*, **24,** 1520–1 (*Dec.*, 1953).

R-PAC is an electronic analogue computer which stores and plays back X-RAC signals. It has been modified by the introduction of a new type of record-ing-storage tube and is used in conjunction with one or other of Buerger's techniques for combining positionally shifted, two-dimensional Patterson functions. J. THEWLIS

548.735.46

2893. On the shape of cylindrical Patterson function peaks. H. L. Yakel, Jr. *Acta cryst.*, **7,** 59–61 (*Jan.*, 1954).

In the course of an investigation of cylindrical Patterson functions as applied to the structures of fibrous polypeptides, the shape function for Gaussian distributions surrounding interatomic vectors in three-dimensional Patterson space projected cylindrically about a unique axis has been determined. This shape function is the Patterson space analogue of an electron distribution function in real space. The projected shape function is such that for the large temperature and disorientation factors associated with fibrous polypeptides there are significant deviations in both peak location and size from an ordinary Patterson projection. A.

548.736 : 541.4

2894. The part played by water in crystalline compounds. J. D. Bernal. *J. Chim. phys.*, **50,** C 1–C 12 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids," colloquium paper [see Abstr. 2866 (1954)]. A general paper, giving a classification of the hydrates into: neso hydrates, containing isolated water molecules; ino hydrates, with chains of water molecules; phyllo hydrates, with layers of water molecules; tecto hydrates with a three-dimensional lattice of water molecules. A table of the 96 known types of structure and an extensive literature list is given. Stress is laid on the close relation between stability and structure. O. TURNER

548.736.1

2895. An X-ray powder study of β-uranium. J. Thewlis. *Acta cryst.*, **5,** 790–4 (*Nov.*, 1952).

Measurements of the line intensities of powder photographs of β-uranium and a 1·4 atomic % Cr–U alloy at 720°C show differences that suggest that further refinement of the structure should be carried out on β-uranium itself and not on the alloy. The measurements show, too, that such a refinement is indeed necessary, the reliability index of the approximate structure proposed by Tucker being about 30%. In the course of the work the Debye characteristic temperature of β-uranium and the linear coefficients of thermal expansion of β-uranium (assumed to be the same as those of the alloy) and of UO_2 have been found. The various data given in the paper are as follows. Beta-uranium: $a = 10{\cdot}759 \pm 0{\cdot}001$, $c = 5{\cdot}656 \pm 0{\cdot}001$ Å; density = 18·11 g cm^{-3}; Debye characteristic temperature = 270°K (all at 720°C). Linear coefficients of thermal expansion from 20°–720°C: 23×10^{-6} per deg C along the *a*-axis; $4{\cdot}6 \times 10^{-6}$ per deg C along the *c*-axis. U–Cr alloy: $a = 10{\cdot}590 \pm 0{\cdot}001$, $c = 5{\cdot}634 \pm 0{\cdot}001$ Å; density = 18·56 g.cm^{-3} (all at room temperature). $a = 10{\cdot}763 \pm 0{\cdot}005$, $c = 5{\cdot}652 \pm 0{\cdot}005$ Å; density = 17·93 g.cm^{-3} (all at 720°C). UO_2: linear coefficient of thermal expansion, 20°–720°C: $11{\cdot}5 \times 10^{-6}$ per deg C. A.

548.736.1

2896. An improved determination of the crystal structure of β-uranium. C. W. Tucker, Jr and P. Senio. *Acta cryst.*, **6,** 753–9 (*Oct.*, 1953).

This reveals that the subsidiary layers in the structure are definitely rumpled. The magnitude of the rumpling is a definite departure from the nearly perfect layering suggested by Shoemaker and Bergman. The question of the rumpling of the main layers in the structure is not resolved by the new work. Thus, the question of whether the crystal is non-centrosymmetric (space group *P4nm*) or centrosymmetric (space group *P4/mnm*) is not settled, although the centrosymmetric space group is perhaps more probable. The new determination reveals an unusually short interatomic distance of 2·59 Å. The only comparable distance in a metal of this type occurs in the α-neptunium structure recently given by Zachariasen. The β-uranium structure is compared in detail, as far as is possible, with refined σ-phase structures. It is found that although the structures may have the same space group, there are real differences in atomic positions, particularly of atoms in the subsidiary layers. The contention of Thewlis that there are intensity differences between β-phase powder patterns from the pure metal and from low chromium alloys at 720°C is considered in detail. The major intensity discrepancy reported by Thewlis for the powder pattern of the low chromium alloy is found not to occur in the single crystal data from an alloy of identical composition. After a consideration of this and other factors, it is concluded that the β-phase structures for the low chromium alloys and the pure metal are identical. A.

548.736.1

2897. Zone structure of graphite. S. Mrozowski. Letter in *Phys. Rev.*, **92,** 1320–1 (*Dec.* 1, 1953).

The zone used by previous workers is bounded by planes of type (000, 2) and ($1\bar{1}0$, 0). It is pointed out that a zone similar to that normally used for hexagonal close packed metals might be more appropriate and the distribution of electrons will then depend on the

magnitude of various energy gaps. No detailed discussion is given. W. M. LOMER

548.736.3

2898. The X-ray diffraction from quartz. O. ADELL, G. BROGREN AND L.-E. HAEGGBLOM. *Ark. Fys.*, **7**, *Paper* 19, 197–211 (1953).

Measurements were made on the width of the rocking curve, the percentage reflection and the reflection coefficient of quartz, for reflecting planes $10\bar{1}0$, $10\bar{1}\bar{1}$, $11\bar{2}0$, $20\bar{2}3$ and $22\bar{4}3$, at wavelengths from 558 X.U. to 4588 X.U. (where applicable). The results, and some of Parratt's (1934), are compared with values calculated from the theory of Darwin (1914) and Prins (1930). A comparison is made with the properties of calcite. A. R. STOKES

548.736.3

2899. The crystallography of solid dinitrogen trioxide at −115°C. T. B. REED AND W. N. LIPSCOMB. *Acta cryst.*, **6**, 781–3 (*Oct.*, 1953).

The unit cell of N_2O_3 crystals at −115°C is tetragonal with $a = 16{\cdot}4$, $c = 8{\cdot}86$ Å and contains 32 molecules of N_2O_3. Complete *hkl* data from single crystals indicate that the space group is D_4^{10}–$I4_12$. The presence of an abnormally high decline of intensities with increasing angle of scattering and the presence of a marked transition at roughly −125°C suggest a disordered structure. Although the electron-density projection along *c* was refined to an agreement of $R = 0{\cdot}22$ (observed reflections only), an interpretation of this projection could not be made and the structure remains unsolved. A.

548.736.3

2900. On a complex structure of Laue spots from thick crystals. J. DESPUJOLS AND P. LUCASSON. *C.R. Acad. Sci.* [*Paris*] **237**, 1021–3 (*Oct.* 28, 1953) *In French.*

Some quartz crystals 3 to 12 mm thick gave striated Laue spots. These are ascribed to bands of different reflecting power in the crystal and a band structure can in fact be shown up by etching in hydrofluoric acid. A. R. STOKES

548.736.3

2901. The position of hydrogen atoms in ice. P. G. OWSTON. *J. Chim. phys.*, **50**, C 13–C 18 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. The positions of maximum stability according to Bjerrum [Abstr. 4747 (1952)] are in a monoclinic structure, without a centre of symmetry. Neutron diffraction and X-rays do not prove or disprove this symmetry. The electronic density distribution is determined at −10°C. Several hypotheses are put forward. The large thermal amplitude at this temperature prevents exact determination of the positions. C. TURNER

548.736.3

2902. The existence of "beta" ice. C. BERGER AND C. M. SAFFER, JR. *Science*, **118**, 521–2 (*Oct.* 30, 1953).

Evidence, both old and new, is quoted in support of the contention that Seljakov's "beta" phase of ice does not exist. A pseudo-trigonal Laue pattern can be obtained from hexagonal ice if the sixfold axis makes a small angle with the X-ray beam. A. R. STOKES

548.736

2903. Change of structure of ferrous oxide at lo temperature. B. T. M. WILLIS AND H. P. ROOKSB *Acta cryst.*, **6**, 827–31 (*Nov.*, 1953).

The structure of ferrous oxide was studied betwe room temperature and liquid-air temperature (90° by X-ray powder photography. The results suppo the conclusion of Jette and Foote that at roo temperature the structure is of the NaCl-type with small and variable number of the Fe^{2+} sites vacan so that the stoichiometric composition FeO is nev attained. At low temperature (below 200°K) th structure is rhombohedral, the new structure ce being derived from the originally cubic cell by a extension along one of the triad-axis directions. Thi is a change of the second order and appears to b directly connected with the transition from the para magnetic to the antiferromagnetic state on coolin through 198°K. The magnitude of the change, a measured at liquid-air temperature, is very sensitiv to the concentration of iron in the oxide. Thus, fo the oxide of minimum iron content the rhombohedra angle α at 90°K is within one minute of the valu (60°) which corresponds to cubic symmetry, whereas α is 59° 23′ for the least iron-deficient oxide. It shown that the powder photograph taken at liquid-a temperature provides a much more sensitive indicatio of the degree of homogeneity of the sample than tha taken at room temperature. A

548.736

2904. The crystal structure of Rh_2B. R. W MOONEY AND A. J. E. WELCH. *Acta cryst.*, **7**, 49–5 (*Jan.*, 1954).

The crystal structure of Rh_2B was determined fro X-ray rotation and Weissenberg photographs. Th unit cell is orthorhombic, with dimensions a = $5{\cdot}42 \pm 0{\cdot}01$, $b = 3{\cdot}98 \pm 0{\cdot}02$, $c = 7{\cdot}44 \pm 0{\cdot}03$ Å The space group is D_{2h}^{16}–*Pnma* with eight rhodiu atoms in the unit cell. The atomic co-ordinate were found by means of Booth's method of "steepes descents," using the intensity data from the *hk*0 an 0*kl* zones. The relation of this structure to othe intermetallic borides is discussed and some comment are made on the type of intermetallic bonding whic may exist. A

548.736

2905. The crystal structure of TiB. B. F. DECKE AND J. S. KASPER. *Acta cryst.*, **7**, 77–80 (*Jan.*, 1954)

The structure was determined by single-crystal an powder methods to be of the FeB type. The dimen sions of the orthorhombic unit cell are $a_0 = 6{\cdot}12$ $b_0 = 3{\cdot}06$ and $c_0 = 4{\cdot}56$ Å. As in other borides c composition MB, the boron atoms form zigza chains through the lattice. Short interatomi distances indicate a higher-than-normal valence fo the titanium atoms, when calculated by application o the Pauling equation, $D(n) = D(1) - 0{\cdot}6 \log n$. A

548.736

2906. Contribution to the study of borides of hig boron content. P. BLUM AND F. BERTAUT. *Act cryst.*, **7**, 81–6 (*Jan.*, 1954) *In French.*

The structures of borides of the type XB_4, XB $(XNa)B_6$ and XB_{12} are described, X being an eleme

which the *d* shell immediately below the valency ectrons is empty. The co-ordination of boron oms by boron is 3 or 5. The boron radii are of o kinds: in the rigid covalent B–B bonds the radius ries little from 0·86 Å; in the boron-metal bonds, wever, it varies between 0·86 and 1·10 Å. Pauling's eory does not give a satisfactory quantitative aluation of the valencies in these borides; Kiessling ached a similar conclusion in his study of borides lower boron content. A.

548.736.3 : 535.33.07 : 537.531

Some atomic planes in quartz suitable as lattices in -ray spectroscopy. *See Abstr.* 2464

548.736.3 : 539.133

907. On the crystal and molecular structure of I_2O_2. W. J. DULMAGE, E. A. MEYERS AND W. N. IPSCOMB. *Acta cryst.*, **6**, 760–4 (*Oct.*, 1953).

The crystal structure of nitric oxide dimer is onoclinic, $P2_1/a$ with two N_2O_2 molecules in a unit ell of dimensions, $a = 6·68$, $b = 3·96$, $c = 6·55$ Å nd $\beta = 12·79°$. Each dimer has two possible rientations, thus accounting for the observed residual ntropy of 1·5 e.u. per mole of dimer. Average tomic parameters of one molecule, referred to the entre of symmetry as the origin, are $x_1 = 0·228$, $_1 = 0·121$, $z_1 = 0·194$, $x_2 = 0·160$, $y_2 = -0·101$ nd $z_2 = 0·241$. The statistically-averaged dimer is rectangular planar molecule with a short edge of ·12 ± 0·02 Å and long edges of 2·40 Å. The X-ray vidence cannot distinguish between parallel or anti-arallel orientation of NO groups within the dimer. Although the average of the two long edges of the nolecule is 2·40 ± 0·01 Å, models in which these listances are different from one another by any value etween 0 and almost 0·5 Å are compatible with the lata, but the quantitative agreement is insignificantly etter when these distances are equal. A.

548.736.4

2908. The part played by water in the structure of graphitic acid. R. E. FRANKLIN. *J. Chim. phys.*, **50**, C 26 (*July–Aug.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. This acid has a structure where a layer of carbon is surrounded by two layers of oxygen and hydrogen. By changes in humidity of the surroundings, one or two monomolecular layers of water can be introduced. X-ray measurements show continuity between the dry $(O_xH_y)_n$ layers and the absorbed water layers. C. TURNER

548.736.4 : 538.222

2909. Study of the water molecule in the crystal $Li_2SO_4.H_2O$. M. SOUTIF AND Y. AYANT. *J. Chim. phys.*, **50**, C 107–C 109 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. Nuclear resonance signals for a set of crystal orientations serve to fix the positions of the H atoms. H– –H distance 1·57 Å, H H axis at 46° to the binary axis, etc. D. H. WHIFFEN

548.736.4 : 538.222

2910. Position of the protons in $CuCl_2.2H_2O$ determined by the method of nuclear magnetic resonance. N. J. POULIS AND G. E. G. HARDEMAN. *J. Chim. phys.*, **50**, C 110–C 113 (*Sept.*, 1953) *In French.*

"Water molecules in solids" colloquium paper [see Abstr. 2866 (1954)]. The resonances of a set of orientations of a single crystal are observed, but interpretation is complicated by the paramagnetic Cu ions. With observations above the critical field, i.e. at 8920 oersteds at 3·03°K, the H atoms are found to be at $x = 0·98$, $y = 3·05$ and $z = 0·92$ Å.

D. H. WHIFFEN

548.736.4

2911. Crystal class of Na_2SO_4 III. D. R. DASGUPTA. Letter in *J. chem. Phys.*, **21**, 2097 (*Nov.*, 1953).

From powder photographs $a = b = 13·45$ Å, $c = 7·879$ Å, 16 molecules per unit cell, probable space group $I\bar{4}2d$. This contradicts Fravel [*J. chem. Phys.*, **8**, 290 (1940)]. A. R. STOKES

548.736.4

2912. The structure of α(AlCrSi)–$Cr_4Si_4Al_{13}$. K. ROBINSON. *Acta cryst.*, **6**, 854–9 (*Nov.*, 1953).

The crystal structure of the intermetallic compound $Cr_4Si_4Al_{13}$ has been determined. The main framework of the structure is a network of linked tetrahedra of Cr, Si and Al atoms, the latter being in 4-co-ordination. The form of the first prominent Brillouin zone of the structure suggests that Cr has a negative "effective valency" in this compound, and electron counts indicate a small excess of electrons in the Cr atoms. Usually short interatomic distances between Cr and Al, similar to those previously reported for Mn and Al in Mn_3SiAl_9, occur in the structure. A.

548.736.4 : 539.132 : 535.375.54

Structure of crystals of copper chloride and of double chlorides of copper and of alkali metals. *See Abstr.* 2320

548.736.5

2913. The structure of hexahydrated magnesium hypophosphite. A. RODRÍGUEZ PEDRAZUELA, S. GARCÍA-BLANCO AND L. RIVOIR. *An. Real Soc. Españ. Fis. Quim.*, **49(A)** 255–62 (*Sept.–Oct.*, 1953) *In Spanish.*

The crystal structure of the $Mg(H_2PO_2)_2.6H_2O$ which crystallizes in the tetragonal system with $a = 10·36 + 0·02$ Å and $c = 20·46 + 0·02$ Å was determined. The number of molecules per unit cell is eight and the corresponding space group is $D_{4h}^{20} - I4/acd$. Each atom of phosphorus is surrounded by two atoms of oxygen at 1·52 Å and these atoms of oxygen have a distance between them of 2·66 Å, forming an angle of 109°. The magnesium has a co-ordination number of six. The water molecules which surround it form a lightly distorted octahedron, the oxygen atoms of the axis *c* has a distance of 20·1 Å from the magnesium and the oxygen atoms of the twofold axis are at 2·07 Å. These atoms of oxygen are linked to the hypophosphite group by means of hydrogen bonds. A.

548.736.5

2914. Studies on polymorphism. I. The polymorphism of $K_2Li[AlF_6]$. H. G. F. WINKLER. *Acta cryst.*, **7**, 33–40 (*Jan.*, 1954) *In German.*

$K_2Li[AlF_6]$ shows an enantiotropic transformation at 470 ± 5°c. The space group of the low-temperature modification is $R\bar{3}m$ while that of the high-temperature form is $C3m$. The structure of the latter has been determined, that of the former having

been given elsewhere. The possible process of the polymorphic transformation is discussed on a dynamic and energetic basis and attention is drawn to one-dimensional disorder in the structure of the high-temperature modification. A.

548.736.5 : 538.221

2915. Crystal structure and magnetic properties of cobalt ferrite at low temperatures. H. P. ROOKSBY AND B. T. M. WILLIS. Letter in *Nature* [*London*] **172,** 1054–5 (*Dec.* 5, 1953).

Describes results of X-ray measurements on $CoO.Fe_2O_3$ below its transition temperature (90°K), indicating that at low temperatures the structure is approximately tetragonal ($c/a = 0{\cdot}9988$ at 80°K) while above the transition temperature it is cubic. The result is discussed in relation to the mechanism of the magnetic transition. E. P. WOHLFARTH

548.736.6

2916. Unusual X-ray diffraction effects from a crystal of wollastonite. J. W. JEFFERY. *Acta cryst.*, **6,** 821–5 (*Nov.*, 1953).

Crystals of wollastonite from Devon are shown to be composites of monoclinic and triclinic forms. Streaks in the a^* direction on odd layer Weissenberg photographs show the presence of very thin plates parallel to bc. The changes from one lattice to another correspond to "mistakes" of $\frac{1}{2}b$ in packing. The occurrence of these mistakes is explained in terms of the structure. The alternative descriptions of the occurrence of the two triclinic forms in terms of twinning are given, and related to the theory of twin formation. Space-group twinning is discussed in relation to the polymorphism of wollastonite. A.

548.737

2917. Organic crystals and molecules. Theory of X-ray structure analysis with applications to organic chemistry. J. M. ROBERTSON. *London: Oxford University Press* (1953) 352 *pp.*

548.737 : 539.152.2

2918. Proton magnetic resonance experiment on a single crystal of oxalic acid dihydrate, $(COOH)_2.2H_2O$. J. ITOH, R. KUSAKA, R. KIRIYAMA AND S. YABUMOTO. Letter in *J. chem. Phys.*, **21,** 1895–6 (*Oct.*, 1953).

Details of the 7 components observed for the proton resonance of a single crystal of $(COOH)_2.2H_2O$ fix the exact positions of the H atoms. H bonding but no oxonium ion is found. D. H. WHIFFEN

548.737 : 535.347 : 535.5

2919. Polarization dichroism, form birefringence, and molecular orientation in crystalline haemoglobins. M. F. PERUTZ. *Acta cryst.*, **6,** 859–64 (*Nov.*, 1953).

The three principal absorption coefficients of the oxyhaemoglobin molecule were determined at $\lambda =$ 5800 Å, using crystals of horse haemoglobin in which the molecules lie on lattice points. The coefficients are defined by an ellipsoid of revolution with an axial ratio of $2{\cdot}6(\pm 0{\cdot}1)$, the short axis of the ellipsoid enclosing an angle of $10°(\pm 1°)$ with the long axis of the molecule. This result was used to find the orientation of the molecules in two forms of human haemoglobin. A comparative study of the molecular dichroism of different haemoglobin derivatives showed that oxy-, carboxy- and methaemoglobin and the addition compounds of methaemoglobin with azid and imidazole all have, within the limits of erro the same dichroic ratio of 2·6. Reduced haemoglobi alone has a dichroic ratio of 4·5. A similar differenc was found between the dichroic ratios of reduce and metmyoglobin. The birefringence of wet crystal of horse methaemoglobin changes with the refractiv index of the suspension medium. The crystals wer found to possess a strong negative intrinsic bire fringence, which is compensated and masked by positive form birefringence. n_α (intrinsic) is paralle to the direction of least absorption. n_γ (form encloses a small angle with the long axis of th haemoglobin molecules. A

548.73

2920. Studies on the sharp extra reflections from phloroglucine dihydrate crystals. II. Effect of tem perature. M. N. DATTA. *Indian J. Phys.*, **26,** 452– (*Sept.*, 1952).

For Pt I, see Abstr. 6899 (1951). The intensitie of the sharp extra spots in the Laue photograph o phloroglucine dihydrate were measured at differen temperatures. It was found that intensities did no change appreciably with rise of temperature. It wa also found that dehydration and breaking-up of the crystal into a microcrystalline aggregate began to take place at some temperature between 48°C and 58°C Heating for different durations at 58°C showed tha the breaking-up and dehydration took place gradually and was appreciable for heating for 45 min and complete for heating for about 3 hr. The nature o the sharp extra spots and their persistence with unchanged extension as long as Laue spots were present showed that the origin of these spots cannot be due to the defect structures originating from removal of H_2O molecules from lattice sites. A

548.737

2921. An X-ray study of andrographis crystal. B. S. BASAK AND D. R. DASGUPTA. *Indian J. Phys.*, **26,** 539–42 (*Nov.*, 1952).

548.737

2922. Scattering domains around the reciprocal lattice points of benzil crystal by photographic photometry. R. K. SEN. *Indian J. Phys.*, **27,** 1–10 (*Jan.*, 1953).

Equi-intensity lines around the (40·0), (22·0) and (40·2) reciprocal lattice points of benzil in the different reciprocal lattice planes have been drawn from the measurements of the intensity distribution in the different extra spots observed in the Laue photographs of benzil. The shapes of the equi-intensity surfaces are discussed in the light of the thermal theories. The observed surfaces agree with the results of the thermal theories. A.

548.737

2923. Structure of tetraphenyl ethylene. M. N. DATTA. *Indian J. Phys.*, **27,** 25–30 (*Jan.*, 1953).

The crystal was found to belong to the holoaxial monoclinic system with the axial ratio $a : b : c =$ $1{\cdot}213 : 1 : 1{\cdot}078$, $\beta = 68°\,20'$. The crystal has a high refractive index which is due to (C–C) atoms which has a high absorption band near ultraviolet spectrum. Number of molecules per unit cell was found to be

ne, which shows that the crystal has neither glide lane nor screw axis. A.

548.737

2924. The stereochemistry of molecules containing he C=C=N group: The crystal structure of *N*-nethyl-2 : 2-dimethylsulphonylvinylidineamine. P. J. WHEATLEY. *Acta cryst.*, **7**, 68–72 (*Jan.*, 1953).

A three-dimensional structure analysis of a compound containing the group =C=C=N—R is described. All four atoms in this chain are shown, rather surprisingly, to be linear. The bond number of the central carbon atom in the multiply-linked chain is shown to be very high, being joined on the one side to a nitrogen atom by what appears, from the length of 1·154 Å, to be a triple bond, and on the other side to a carbon atom by what seems, from the length of 1·342 Å, to be a double bond. The occurrence of this "pentavalent" carbon atom suggests that, in condensed systems of this type, bond length is not a satisfactory criterion of bond order. A.

548.737

2925. An X-ray investigation on tetraphenylethylene crystal. M. N. DATTA. *Indian J. Phys.*, **27**, 126–8 (*March*, 1953).

A systematic study of X-ray reflections from a large number of planes, indicates that the space group of this crystal is $P2_1/m$. The estimated intensities of these planes show that the molecule does not lie in any simple crystallographic plane. A.

548.737 : 535.323

2926. Study of diffuse X-ray reflection by a single crystal of meta aminophenol. M. N. DATTA. *Indian J. Phys.*, **26**, 371–5 (*July*, 1952).

The refractive indices in different directions of the crystal were measured, the plane of molecule was taken to be in a perpendicular direction of least refractive index, namely in the *c*-direction. The axes of the crystal were found, by rotation photographs, to be: $a = 6{\cdot}310$ Å, $b = 11{\cdot}12$ Å and $c = 8{\cdot}60$ Å. Planes (211), (330), (213), (212), (340), (321), (350) and (333) show extra Laue reflections, of which the extra Laue reflections from (211) persist from 18′ to 6·8′ and yield an interesting result when plotted on reciprocal lattice, namely the derangement waves pass strictly on the *b*-axis. A.

548.737 : 539.132

2927. The structures of molecular compounds exhibiting polarization bonding. I. General introduction and the crystal structure of phenoquinone. T. T. HARDING AND S. C. WALLWORK. *Acta cryst.*, **6**, 791–6 (*Oct.*, 1953).

"Polarization bonding" is the term which has been introduced to describe the interaction between polarizing and polarizable molecules. In crystalline molecular compounds formed by nitro-compounds and quinones, such interaction is revealed by the unusual plane-to-plane stacking of the molecules rather than by a shortening of the van der Waals separations. Crystals of phenoquinone, $(C_6H_5OH)_2 . C_6H_4O_2$, are monoclinic, space group $P2_1/c$, with two formula units in each cell of dimensions $a_0 = 11{\cdot}16$, $b_0 = 5{\cdot}97$, $c_0 = 11{\cdot}48$ Å, $\beta = 100°$. By two-dimensional Fourier methods it is found that each quinone molecule is sandwiched between two centro-symmetrically related phenol molecules arranged parallel to the quinone with perpendicular separations of 3·33 Å. Such groups of three molecules are stacked in columns parallel to [201] and the columns are linked by hydrogen bonds of length 2·64 Å between phenolic OH groups and quinone oxygen atoms. It is suggested that the polarization bonding in complexes of this type might be interpreted as the formation of partial molecular π-bonds. A.

548.74

2928. Electron diffraction at metal single crystals up to 1000°C. C. MENZEL-KOPP AND E. MENZEL. Note in *Z. Naturforsch.*, **8a**, 499–500 (*Aug.*, 1953) *In German.*

The chief difficulty in examining a heated specimen by electron diffraction is the disturbance of the electron beam by the magnetic field of the heating current. It is shown that this can be overcome by using half-wave rectified a.c. for heating. The diffraction pattern is clear during the dead half-cycle, while the beam is deflected away from the specimen and the photographic plate during the other. Results of observations on Cu and Au crystals from room temperature to the melting point are described. With increasing temperature the spot patterns fade, starting from the outside, and the higher index Kikuchi bands become fainter. Two alternative explanations, one depending on lattice vibrations and the other on the presence of a layer of mobile atoms on the surface of the crystal, are discussed.

M. R. HOPKINS

548.74

2929. Excess and defect Kikuchi-bands. Y. KAINUMA. Note in *J. Phys. Soc. Japan*, **8**, 685–6 (*Oct.*, 1953).

Experimental conditions for appearance in transmission and reflection are given. A theoretical explanation is given, taking the effect of absorption into consideration. C. TURNER

548.74

2930. Structure analysis of single crystals by electron diffraction. III. Modifications of alumina. J. M. COWLEY. *Acta cryst.*, **6**, 846–53 (*Nov.*, 1953).

For Pt II, see Abstr. 8119 (1953). An electron-diffraction study of the oxide films formed by heating aluminium foil in air on metal grid supports has revealed the occurrence of a number of new phases arbitrarily designated the λ, μ, ν, ξ and ξ' phases. Except for the λ-phase, all these phases may be indexed in terms of hexagonal unit cells with $a \sim 5$ Å and $c \sim 14$ Å, and appear to be intermediate between the α- and γ-alumina phases. The λ-phase is orthorhombic, pseudo-tetragonal, with $a = b = 7{\cdot}63$ and $c = 2{\cdot}89$ Å and has a superlattice with a unit cell containing 14 normal unit cells. Poor quality single-crystal patterns of the λ-phase have been used in the structure analysis of the average unit cell and the superlattice unit cell as a demonstration of the amount of information which can be derived from imperfect single-crystal patterns and of the effectiveness of image-seeking methods in the interpretation of Patterson projections obtained from electron-diffraction data. The [001] projection of the average unit cell was refined by using two methods of

$\frac{1}{2}(E'_{hk} + E^2_{hk}/E'_{hk})$ as Fourier coefficients, the E'_{hk} being the structure factors calculated for the approximate structure found by image-seeking. The composition of the λ-phase is approximately $3NiO.5Al_2O_3$. A.

548.74

2931. Continuous recording by electron diffraction, of chemical or physical changes and applications. J.-J. TRILLAT AND N. TAKAHASHI. *Acta cryst.*, **7**, 15–16 (*Jan.*, 1954) *In French.*

Modifications are described in electron diffraction apparatus which make it possible to obtain a continuous photographic record of structural changes taking place as a function of time, temperature or other factors. The technique opens up a wide field of investigation, particularly in the study of structural changes, diffusion of metals, alloy formation a chemical reactions.

548.

2932. Neutron diffraction study of tetragon potassium dihydrogen phosphate. S. W. PETERSO H. A. LEVY AND S. H. SIMONSEN. Letter in *J. che Phys.*, **21**, 2084–5 (*Nov.*, 1953).

Three sets of single crystal projections: (*hk*0) zon room temperature, $\lambda = 1{\cdot}16$ Å; (*hk*0) zone, ~140° $\lambda = 1{\cdot}062$ Å; ($\bar{h}$01) zone, r.t., $\lambda = 1{\cdot}16$ Å, give pea for H-atoms consistent with a centred or an u centred model (the latter seems more plausible fro infrared measurements). The parameters for O a identical at both temperatures, the length of t H-bond is 2·48 Å. The O–H distance (from t uncentred model) is 1·085 Å. C. TURN

GEOPHYSICS 55

550.361

2933. The earth's internal thermal state. A. DAUVILLIER. *C.R. Acad. Sci.* [*Paris*] **237**, 1202–3 (*Nov.* 16, 1953) *In French.*

From a comparison of the production of geothermal energy by the 4 radioactive elements, Th^{232}, U^{238}, U^{235} and K^{40}, with volcanic activity in past ages, the cyclic theory of Joly is confirmed; although it is concluded that each cycle must be of ten times longer duration than Joly's estimate based on too short a period for the age of the earth. Because of the gradual depletion of the radioelements the intervals of quiescence between successive Joly cycles will increase progressively. D. R. BARBER

550.37 : 621.317.39 : 621.317.723

2934. Centre of Sahara research; terrestrial physics section Béni-Abbès laboratory. First results obtained during spring 1953. L. DEMON, P. DE FÉLICE, H. GONDET, Y. KAST AND L. PONTIER. *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 126–37 (*Sept.*, 1953) *In French.*

Describes the construction of an electrometer of the Mattias and Gunn type for the measurement of the earth's electric field and shows the great effect of sandstorms on the field. The sandstorm produces a hundredfold increase in the field when the visibility is reduced to a few hundred metres but very slight rainfall produces an immediate decrease in the field. Measurements on the moisture content of sand dunes by resistivity measurements have also been made and these suggest that the moisture comes upward from the ground rather than from the air. A resistivity psychrometer has been constructed and a few preliminary measurements made. J. M. HOUGH

550.371

2935. On the variation of the earth's electric field. A. N. TIKHONOV AND N. V. LIPSKAYA. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 547–50 (1952) *In Russian.*

At attempt is made to relate the observed variations in the earth's electric and magnetic field by the use of Maxwell's equations and certain simplfying assumptions. The assumption is made that the earth behaves like a conductor of depth L and conductivity k. The theory is applied to experimental data for thr stations and good agreement is obtained for tw L is found to be about 1000 km and k abo 0·01 mho/m. J. M. HOUG

550.37

2936. On the electric field induced by the vertic component of geomagnetic variation. A. P. BO DARENKO. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 367–70 (1953) *In Russian.*

A theoretical formula is developed by considerin the existence of strata of different electrical propertie Graphs are given based on published data to sho that this correlation is satisfactory. J. M. HOUG

550.38 : 551.510.53

2937. Experimental determination of the tot intensity of the terrestrial magnetic field in the low region of the upper atmosphere (*E*-layer). M. CUTOL *Nuovo Cimento*, **10**, 915–25 (*July*, 1953) *In Italian.*

For previous work see Abstr. 2616 (1954). A important consequence of gyrointeraction of radi waves is the measurement of terrestrial magnetic fie H in the E-layer with sufficient precision to reve the presence of those electric currents in the ion sphere which are postulated to account for certa terrestrial magnetic variations. The method is simp to measure H continually in the E-layer. It is on necessary to find resonance curves with two hum lying equidistant from the local gyrofrequency. T mean value of two frequencies (or wavelengths) whe the humps are lying is the gyrofrequency f_r. Values H found in Italy by gyrointeraction are tabulated. O other method easier and at the same time sufficient accurate is self-modulation (or self-interaction) radiowaves. If a radiowave, modulated for instan at 230 Mc/s and at strictly constant modulati percentage, is emitted varying its carrier frequen around the local gyrofrequency, then at the receivi station at least 200 km from the transmitter t modulation percentage of the signal varies accordi to diagram given. The minimum of modulati percentage is on gyrofrequency. The mean value the frequencies on which maxima lie gives gy

frequency and hence H in the E-layer. Some values of H found in Italy by self-modulation are tabulated. The degree of precision of the two methods may reach the fourth decimal figure. The small changes of the frequencies on which the maxima are lying show the variations of H in the ionosphere. H in the E-layer is smaller than on the earth. A.

550.38 : 551.510.535 : 538.566.3

Measurements of the terrestrial magnetic field in the *E*-layer. *See Abstr.* 2617

550.4

2938. Geochemistry. V. M. GOLDSCHMIDT. Edited by A. MUIR. *Oxford: Clarendon Press* (1954) 744 *pp.* [*International Series of Monographs on Physics.*]

A wide survey of the whole field of geochemistry with its applications in the related fields of pedology and plant nutrition. The first part describes the charges in the distribution of the elements during the formation of the earth, and the quantitative aspects of rock weathering, while the second is concerned with the abundance of the individual chemical elements.

550.839

2939. The uranium content of some specimens of phosphate rock. C. F. G. DELANEY, C. M. E. MATTHEWS AND J. H. J. POOLE. *Sci. Proc. Roy. Dublin Soc.*, **26,** *No.* 10, 165–72 (1953).

Three methods for determining the U content of thick samples are described: β-counting by G.M. counter, α-counting by scintillation counter and α-counting by nuclear emulsion plates. Good agreement was found in tests using phosphate rock specimens whose K and Th contents are negligible.

M. A. GRACE

ATMOSPHERE . METEOROLOGY 551.5

551.508.4 : 621.317.39 : 621.317.727

2940. Potentiometer operated by atmospheric pressure. D. R. GRANT. Note in *J. sci. Instrum.*, **30,** 487–8 (*Dec.*, 1953).

Use was made of a 1½ in. long, 80% Au, 20% Pt, 1000 Ω film resistor, a force of 4 g. wt being applied between the film and the contact which was operated by means of a lever attached to two small aneroid capsules. Results showed an accuracy better than ±1 mb over the range 30–1050 mb. G. HOWELLS

551.508.9 : 623.5 : 629.13

2941. Measuring air density for aircraft gunnery computers. H. F. COLVIN, III. *Tele-Tech*, **12,** 68–70, 140–1 (*Sept.*, 1953).

Temperature and pressure are measured during flight by means of a resistance thermometer and a diaphragm/potentiometer arrangement respectively so that the ratio of the two values, which is proportional to the density of the air through which the aircraft is flying, can be computed automatically by a bridge circuit controlling the spindle rotation of an output motor. Values are given in terms of the density at 15°C and 29·92 in. Hg. Errors in the temperature readings due to adiabatic compression and skin friction depend on the true air speed and are automatically eliminated. The system may be used at altitudes up to 50 000 ft and air speeds up to 650 knots.

G. HOWELLS

551.508.92

2942. Measurement and recording of [meteorological] visibility. L. FOITZIK. *Optik*, **10,** *No.* 10, 513–16 (1953) *In German.*

Details are given of a recording photoelectric visibility-meter operating over an effective optical path of 500 m. A searchlight beam is reflected back along its path by a triple-mirror system to a concave mirror placed near the source. At the focus of this mirror the beam, modulated at 240 c/s, is allowed to fall on a photocell: a similarly modulated beam of controlled intensity acts as a comparison source. A rotating shutter allows the two beams to illuminate the cell alternately, the out-of-balance photocurrent operating, after amplification, a synchronous motor linked to the recording stylus. Facsimiles of some typical records of atmospheric transmission are reproduced. D. R. BARBER

551.510.535

2943. Study of the ionosphere by extraterrestrial radio waves. A. P. MITRA. *Indian J. Phys.*, **26,** 495–511 (*Oct.*, 1952).

Presents a connected account of a novel method of studying the ionosphere. Four different types of measurements on extraterrestrial waves are discussed for this purpose, namely (i) ionospheric refraction, (ii) ionospheric attenuation, (iii) twinkling of "radio stars," and (iv) effects of sudden ionospheric disturbances. The available experimental results are compared with ionospheric theory and further lines of investigation which might profitably be followed are indicated. A.

551.510.535

2944. Studies on ionospheric storms. H. UYEDA. *Rep. Ionosphere Res. Japan*, **6,** 169–77 (*Dec.*, 1952).

Brief considerations of classification, characteristics, and development of ionospheric storms resulting from two years' work in Japan. G. M. BROWN

551.510.535

2945. Bifurcation of the *E* region. J. R. LIEN, R. J. MARCOU, J. C. ULWICK, D. R. MCMORROW, L. B. LINSFORD AND O. C. HAYCOCK. Letter in *Phys. Rev.*, **92,** 508 (*Oct.* 15, 1953).

The results of four rocket sounding flights, made at New Mexico in November 1946, April 1947, June and July 1953, giving the vertical electron density across the E-layer are presented. The April 1947 and June 1953 curves indicate marked stratification of the E layer. The measured values of electron density are in good agreement with values deduced from simultaneous normal incidence (P', f) radio sounding data.

W. J. G. BEYNON

551.510.535

2946. Ionospheric observations in the Kerguelen Islands. J. LE GALL, B. MONGIN AND H. MUNIER. *C.R. Acad. Sci.* [*Paris*] **237,** 927–8 (*Oct.* 19, 1953) *In French.*

An ionospheric station under the auspices of S.P.I.M. has been established in the Kerguelen Islands (49·6° S, 70° E). Regular observations have

been made since Feb., 1953, indicating an influence of magnetic dip, particularly in the *F*2 region.

G. M. BROWN

551.510.535

2947. Investigation of travelling disturbances in the ionosphere by continuous-wave radio. Y. V. SOMAYAJULU, B. RAMACHANDRA RAO AND E. BHAGIRATHA RAO. Letter in *Nature* [*London*] **172,** 818–20 (*Oct.* 31, 1953).

A simple method is described for tracking *F*2 travelling disturbances by analysis of c.w. signal-intensity records received over a 640 km path from Madras on frequencies of 9·59 Mc/s (afternoons) and 4·92 Mc/s (evenings and nights). Simultaneous observations on oblique-incidence pulse transmissions from Madras indicate the effective modes of transmission, making interpretation of the records possible. Velocities in the range 200–400 m/sec have been obtained. Another method is described employing simultaneous recording (at Waltair) of c.w. transmissions from two distant short-wave transmitters (Calcutta and Dacca) radiating on frequencies very close to each other. When the transmission paths involve a single-hop reflection at the ionosphere, similar intensity variations on the two traces, displaced in time, lead to estimates of 150–250 m/sec for the component velocity of travelling disturbances along the line joining the reflection points.

G. M. BROWN

551.510.535

2948. Origin of the *E* layer of the ionosphere. E. BAUER AND T.-Y. WU. *Phys. Rev.*, **92,** 1101–5 (*Dec.* 1, 1953).

The electron concentration in the *E* layer has been calculated as a function of height according to the theory of the pre-ionization of molecular oxygen by the sun's radiation (Nicolet) and subsequent dissociative recombination (Bates and Massey). The calculations are based on the recent work of Moses and Wu on the distribution of molecular and atomic oxygen in the atom-molecule transition region. It is shown that both the observed height and the value of the peak electron density can be accounted for satisfactorily. The photo-ionization of atomic oxygen which leads to a peak in the region of the F_1 layer is also examined, but it does not seem possible to explain the observed effective recombination coefficient for the F_1 layer on the basis of a theory involving atomic and molecular oxygen alone. A.

551.510.535 : 537.568

2949. Recombination coefficient in the *F*-regions: a possible new process of ionization of nitrogen molecules. R. B. BANERJI. Letter in *Nature* [*London*] **172,** 953–4 (*Nov.* 21, 1953).

The day-time recombination coeff. in the *F*2 layer can be accounted for in terms of dissociative recombination with N_2^+ molecules. The latter, also required for the twilight flash phenomenon, could be produced by charge-transfer from O^+ to excited $N_2'(A)$. Almost exact resonance occurs if the atomic oxygen is left in the ^1S state. Only 2% of the N_2 molecules present in the *F*-layer need be excited to the *A* state. The night-time decay of ionization must be mainly due to attachment. G. M. BROWN

551.510.535 : 538.566

Radio-wave propagation in the ionosphere. S *Abstr.* 2613–18

551.510.535 : 621.396.11 : 621.317.7

2950. Automatic ionospheric height recorder. C CLARKE AND E. D. R. SHEARMAN. *Wireless Eng* **30,** 211–22 (*Sept.*, 1953).

Describes a commercial equipment, based on design by Naismith and Bailey, for measuring th virtual height of reflection of ionospheric echoes as function of transmitted frequency. A pulse tran mitter consisting of a master oscillator and pow amplifier is tuned through the frequency range 0·65 to 25 Mc/s in 5 bands. The receiver is separate tuned and is kept in step with the transmitter by frequency discriminator and servo-mechanism. Th receiver output is presented on two c.r.t.'s, one fo monitoring and one for photographic recording, eac displaying a linear time-base sweep. Height an frequency calibrations, which are derived from crystal source, are displayed and a crystal-controlle time switch is incorporated for the automatic opera tion of the equipment. A

551.510.535 : 621.396.11 : 621.396.96

2951. A high precision ionospheric sounding equip ment. B. M. BANERJEE AND R. ROY. *Indian J. Phys* **26,** 473–94 (*Oct.*, 1952).

An apparatus of high resolving power and accurac is described. It utilizes a transmitter generatin 50 kW sounding pulses of 6–30 μsec duration, inte changeable receivers of 50–200 kc/s bandwidth and 12-line raster time base to produce a greatly expande presentation of the pulse echoes. A study of th height-measuring accuracy and resolving power o such instruments, in both ideal and practical con ditions, is included. A

551.55

2952. Some notes on the atmosphere eddy movement and friction. T. HESSELBERG. *Meteorol. Ann.*, 3 *No.* 11, 295–310 (1953).

Eddy movements depend upon how wind velocit is defined. It is shown to be better to use the mea wind as that corresponding to specific momentun rather than the mean velocity of the air because ther is no transport of air mass and the laws of continuit can be used in a simple form. From expression obtained for the vertical transport of specific momen tum with eddy motion it is shown how the travel of particle near the ground decreases rapidly. With a anemometer exposed at a height of 10 m above leve open terrain the effect of the ground is negligible Expressions are obtained for the variation of velocit and the coefficient of viscosity with direction due t eddy motion and for the transport of individua particles. R. S. REA

551.571.

2953. Direct measurement of humidity gradient M. ELNESR. *C.R. Acad. Sci.* [*Paris*] **237,** 1270– (*Nov.* 16, 1953) *In French.*

The vertical gradient of humidity plays an im portant part in the propagation of very high fre quencies in the lower atmosphere. For its direc measurement Cu-constantan thermocouples wer

employed, 90 cm apart vertically with the lower ones 5 cm from the ground. An expression is derived in the form $\Delta r = \frac{1}{\alpha}\left(2\frac{c_p}{L} + m\right)(R_c + G)i$ where Δr is the humidity gradient, α the e.m.f. per °C for the thermocouples, c_p the specific heat at constant pressure, L the latent heat of vaporization at the lower level, m a constant proportional to a function of the temperature, R_c the external resistance of the apparatus, G the galvanometer reading and i the current. In tests a mean value for Δr was $0{\cdot}109 \pm 0{\cdot}012$ compared with a calculated value of $0{\cdot}110 \pm 0{\cdot}012$.

R. S. READ

551.574

2954. Giant condensation nuclei from bursting bubbles. A. H. WOODCOCK, C. F. KIENTZLER, A. B. ARONS AND D. C. BLANCHARD. Letter in *Nature* [*London*] **172**, 1144–5 (*Dec.* 19, 1953).

High-speed motion pictures of small bubbles bursting at air/salt-water interfaces were taken. It is seen that each bubble, on bursting, ejects about five droplets, evaporation of the water from which leaves a salt residue similar in weight to salt nuclei found in the atmosphere and believed to be nuclei for rain formation.

T. C. TOYE

551.591

2955. Vision through the atmosphere. W. E. K. MIDDLETON. *Toronto: University of Toronto Press; London: Oxford University Press* (1952) xiv + 250 *pp.*

Review in *Nature* [*London*] **172**, 1118 (*Dec.* 19, 1953).

551.593.5 : 525.73

2956. Quantitative evaluation of multiply scattered and diffusely reflected light in the direction of a stellar source in a Rayleigh atmosphere. D. DEIRMENDJIAN AND Z. SEKERA. *J. Opt. Soc. Amer.*, **43**, 1158–65 (*Dec.*, 1953).

The specific intensities of non-parallel light in the direction of a stellar source, such as the sun, resulting from multiple scattering and diffuse ground reflection of a unit flux of parallel radiation incident on a plane parallel, Rayleigh atmosphere, equivalent to the Earth's atmosphere in composition and density, are evaluated following Chandrasekhar's extension of the Rayleigh theory. Values are given as a function of direction of the source and normal optical thickness covering the visible and near ultraviolet spectrum. It is shown that the flux resulting from such non-parallel radiation, for a sufficiently small solid angle (10^{-3} radian) around the source, when the latter is within 50° or less of the vertical, is of the order of 10^{-5} of the reduced flux of the direct solar beam, for radiation within the visible range. The relative importance of the scattered light increases with normal optical thickness and zenith distance of the source. It is pointed out that certain observations of apparent atmospheric transmissions of solar radiation in the blue end of the visible spectrum exceed in magnitude significantly the values obtained from the exact Rayleigh scattering theory and it is suggested that this anomaly may be due to non-Rayleigh particles existing in the high atmosphere, with strong forward scattering characteristics.

A.

551.593.9

2957. Stellar absorption lines in night-sky spectra. J. W. CHAMBERLAIN AND N. J. OLIVER. *Astrophys. J.*, **118**, 197–9 (*Sept.*, 1953).

Evidence is presented that the blue and violet regions of the light of the night sky are primarily composed of starlight rather than airglow emission. Most of the features heretofore believed to be emission bands are probably unreal, the deceptive appearance being produced by surrounding absorption lines. This interpretation not only explains numerous previously unidentified features but also may reconcile the observed intensities of true emissions with their theoretical transition probabilities. Moreover, the night-sky continuum, so predominant in the blue, is attributed to stellar, not to airglow, radiation.

A.

551.593.9

2958. Origin of the continuum in the night-sky spectrum. A. B. MEINEL. *Astrophys. J.*, **118**, 200–4 (*Sept.*, 1953).

A re-examination of the continuum of the airglow spectrum in the region 3700–4800 Å has shown that the continuum may be more completely due to starlight than has been supposed. The *H* and *K* lines of calcium and Hδ are found to be prominent on all airglow spectra. The spectral class is definitely earlier than solar (G2), being *F*8 at Hγ and *F*0 at *H* and *K*. The emission at 3914 Å in the airglow is identified as N_2^+ (0, 0) and represents a true permanent aurora due to the excitation by cosmic-ray particles.

A.

551.593.9

2959. Study of the twilight emission from the ionized molecule of N_2, and the neutral N atom. M. DUFAY. *Ann. Phys.* [*Paris*] **8**, 813–62 (*Nov.–Dec.*, 1953) *In French.*

Systematic spectrographic observations of the first negative band system of N_2^+, and of the atomic N lines at 5199 Å show: (1) that the band emission is of variable intensity and shows a strong correlation ($+0{\cdot}55 \pm 0{\cdot}10$) with geomagnetic activity. No systematic intensity-differences are found between dawn and dusk observations. Excitation is by optical resonance of pre-existing N_2 ions excited by u.v. radiation of wavelength < 910 Å, the emission originating in the *E*-layer between 90 and 125 km; (2) the doublet of neutral N at 5197·8 Å and 5200·2 Å also shows variability of emission, is weaker at dawn and shows max. intensity in summer twilight. There is no marked correlation of emission-intensity with geomagnetic disturbance. The results suggest a fluorescent excitation by direct absorption of solar radiation at 3466 Å at an altitude $\sim$ 120 km.

D. R. BARBER

551.593.9 : 535.33.07

2960. A new method of observing the atmospheric emission from the *D*-lines of sodium. J.-E. BLAMONT. *C.R. Acad. Sci.* [*Paris*] **237**, 1320–2 (*Nov.* 23, 1953) *In French.*

Some preliminary results are described of the use of a selective resonance filter for the study of *D*-line emission. The apparatus comprises a chamber filled with Na vapour maintained at 140°c and placed in a magnetic field whose intensity can be varied from

zero to a max. of 4000 oersted. For zero field, monochromatic *D*-line radiation incident on the filter is absorbed by the Na-vapour and re-emitted as resonant radiation without change of wavelength. When the magnetic field is applied, Zeeman splitting results and the wavelength at emergence is thereby modified. It is thus possible to obtain line-profile measurements of the incident radiation by varying the applied field in steps corresponding to a wavelength separation of $\sim 0{\cdot}01$ Å. Examples of the response of the filter to different types of sky radiation (*D*-line emission and absorption) are given. D. R. BARBER

551.593.9 : 535.338.4

2961. Altitude of emission of near-infrared bands of the molecules, OH and O_2, in the high atmosphere during the night. P. BERTHIER. *C.R. Acad. Sci.* [*Paris*] **237,** 928–30 (*Oct.* 19, 1953) *In French.*

Simultaneous photometric measures of band intensity, at two different zenith-distances, indicate that both emissions originate at heights > 100 km the most probable altitude being 130–150 km.

D. R. BARBER

551.594.12 : 523.72

2962. The contribution of solar X-rays to *E*-layer ionization. E. T. BYRAM, T. A. CHUBB AND H. FRIEDMAN. Letter in *Phys. Rev.*, **92,** 1066 (*Nov.* 15, 1953).

Specially designed rocket-borne photon-counters have detected the presence of soft X-rays above about 90 km. The flux of rays >10 Å within the *E*-region is large, providing more than sufficient energy to account for the ionization there. G. M. BROWN

551.594.14

2963. Autoradiography of the atmospheric aerosol. E. MORASCHINELLI. Letter in *Nuovo Cimento*, **10,** 1341–2 (*Sept.*, 1953) *In Italian.*

A sample of the aerosol solid is collected on a nuclear emulsion plate by electrostatic precipitation. An analysis of the α-ray track lengths enables the radioactive materials present to be determined and the present investigation was designed to test whether the disintegration products from emanations become anchored to a solid particle; the results do not favour this hypothesis. J. M. HOUGH

551.594.14

2964. On the radioactivity of the atmosphere of atomic origin. H. GARRIGUE. *C.R. Acad. Sci.* [*Paris*] **237,** 1232–3 (*Nov.* 16, 1953) *In French.*

See Abstr. 921 (1954). Continuation of the measurements on the radioactivity of the snow and the air in the Puy-de-Dôme area of France. J. M. HOUGH

551.594.1

2965. Evolution of the amount of artificial radioactive elements in the atmosphere of Paris. M. ABRIBAT AND J. POURADIER. *C.R. Acad. Sci.* [*Paris*] **237,** 1233–5 (*Nov.* 16, 1953) *In French.*

Records the results of a daily measurement of the β-activity of the air together with results for rain water and tap water. Two peaks in the atmospheric data correspond to periods when there were atomic trials in Nevada and Russia respectively. Rain water measurements show a peak at the time of the Nevada trials but offer little evidence at the period of activity due to lack of rain. The tap water shows a much lower activity and no systematic variations.

J. M. HOUGH

551.594.221

2966. The study of lightning streamers with 50 cm radar. F. J. HEWITT. *Proc. Phys. Soc.* [*London*] *B*, **66,** 895–7 (*Oct.*, 1953).

Radar reflections from lightning discharges inside clouds and to earth were recorded on a continuously rotating drum camera, the recording system being triggered by the noise radiated from the discharge itself. It is tentatively suggested that characteristic echo components detected in the intervals between the successive strokes of a multiple flash to earth are associated respectively with the ionization persisting in the main discharge channel and with the development of junction streamers between different charge centres in the cloud. R. H. GOLDE

551.594.5 : 535.338.4

2967. Rotational temperatures of auroral N_2^+ bands. A. V. JONES, D. M. HUNTEN AND G. G. SHEPHERD. *Astrophys. J.*, **118,** 350–1 (*Sept.*, 1953).

Recent photographs of the spectra of the $\lambda 3914 N_2^+$ auroral band showing complete resolution of the *R* branch yield a temperature estimate of $330° \pm 40°$K at a height of 100–120 km. Although incompatible with other results using the same technique on unresolved spectra, this result agrees with recent measurements with rockets. G. M. BROWN

551.596.1

2968. Study of acoustic wave echoes in the stratified region of the troposphere. G. ECKART. *Acustica*, **2,** *No.* 6, 256–62 (1952) *In French.*

Uses the methods of Bremmer [Abstr. 7473–4 (1949), 1099 (1950)] and Schelkunoff [Abstr. 2729 (1946)]. The influence of those terms which spoil the analogy with electric waves [see Abstr. 183 (1954)] becomes apparent. A.

BIOLOGY 57/59

577.3

2969. Some properties of nervous systems. A. FESSARD. *Cahiers de Phys.*, *No.* 46, 23–33 (*Nov.*, 1953) *In French.*

This review contains a simple account of recent investigations by the methods of electrophysiology, neuro-anatomy and cybernetics and is designed to acquaint the physicist with new branches of biophysics. No new experimental data are presented. R. A. WEALE

578.087.9 : 621.317.755 : 621.373.43

2970. A time-marker for electrocardiography. M. A. BULLEN AND L. A. DAYNES. *J. sci. Instrum.*, **31,** 6–7 (*Jan.*, 1954).

A source of timing signals for use with a c.r.o. in

research electrocardiography is described. Signals derived from 50 c/s mains are provided at four repetition frequencies between 5 and 100 per sec. A.

591.485 : 534.75

2971. The sense of hearing in mosquitoes. H. TISCHNER. *Acustica*, **3**, *No.* 5, 335–43 (1953) *In German.*

Measurements of the sound potential in male animals of a species of mosquitoes, Anopheles subpictus, show that these insects can hear in a small range of frequency between 150 and 550 c/s. The maximum sensitivity occurs at 380 c/s. It corresponds to the sensitivity of the human ear at 2 kc/s. The difference between the threshold level and the level of saturation is 28 phon. The noise produced by the flying female mosquitoes contains a clearly perceptible tone of 380 c/s so that this tone is of great use to the male insect in spite of the general noise of the environment. The noise of flying of the male mosquito will scarcely be picked up by its own feelers as the loudest tone of the spectrum is at the upper limit of its auditory range. The observed effect of doubling the frequency of the Johnston organ may be understood from its construction. The first harmonic of the movement of the clasps working on the pins is larger at a motion of the feeler in the direction of the axis of the antennae than at a motion perpendicular to it. In spite of the small dimensions of the feeler compared with the wavelength the mosquito is able to find the direction from which the female noise of flying is coming. A particular biological importance belongs to the superposition of two sinusoidal sounds which form beats near 380 c/s. The relatively high time of delay of these beats observed in the sound potential has physical origins in the resonance effect of the antennae. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.84

2972. Physical elements of sensory excitation. Y. LE GRAND. *Cahiers de Phys.*, *No.* 46, 17–22 (*Nov.*, 1953) *In French.*

Recent trends in research on sensory excitation are reviewed with special reference to vision. The importance of temporarily unstable conditions—as in the off-effect—is emphasized, as is spatial interaction of the retinal elements. R. A. WEALE

612.84

2973. Use of non-geometrical perspective in the two-dimensional representation of solid objects. P. SHORT. *Nature* [*London*] **172**, 1002 (*Nov.* 28, 1953).

The relation is discussed between object size and various enlargements of the object photographed. A more life-like impression of a photograph will be obtained when the scale is reduced less than would be dictated by the laws of perspective. The actual enlargement ratio varies from person to person.

R. A. WEALE

612.84 : 535.832 : 535.5

2974. Note on protection from glare of car headlamps. A. KÜHL. *Optik*, **10**, *No.* 10, 516–19 (1953) *In German.*

Other workers' measurements on the effects of different combinations of polarizing spectacles and polarization of the beams of the observer's and the approaching cars, are discussed from the point of view of visual adaptation times. It is suggested that only a part of the area of the spectacle should be polarizing. G. F. LOTHIAN

612.843 : 535.43 : 538.566

2975. Receptors of the retina and microwaves. G. TORALDO DI FRANCIA AND L. RONCHI. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 439–41 (1952) *In French.*

Since microwave models of cones have a directive scattering effect, the scattering of an eye was observed through a window in the eye-wall and found to be 4 times more intense at 70° than at 35°.

D. H. WHIFFEN

612.843.31

2976. A new form of anomaloscope. C. R. FORSHAW. *J. sci. Instrum.*, **31**, 16–17 (*Jan.*, 1954).

A new form of instrument combining features of the Rayleigh and Nagel anomaloscopes is described. Results of tests on 217 males show that normal trichromats fall within the 2 standard deviation limits of a normal error distribution and that anomalous trichromats form separate populations merging into the 3 standard deviation limits. A.

612.843.611 : 621.396.963.325

2977. Effect of duration of light adaptation on time required for detection of a target on a simulated PPI scope. J. L. BROWN, A. L. DIAMOND AND H. E. ADLER. *J. Opt. Soc. Amer.*, **43**, 1147–52 (*Dec.*, 1953).

Times required for the detection of a target on a simulated radar screen were determined for various screen luminances after different durations of light adaptation to a luminance of 3100 millilamberts. Increased duration of light adaptation results in increased detection time up to a maximum value which varies with screen luminance. In general, detection time decreases with either an increase in target luminance or a decrease in background luminance for a given duration of light adaptation. Within the range of luminances investigated, changes in target luminance result in a greater change in detection time than comparable changes in background luminance. The implication for radar screen viewing after adaptation to a high luminance is that optimum visibility will be obtained with maximum gain and as much negative bias as is possible without appreciable reduction of target luminance. A.

612.843.613

2978. Influence of the state of adaptation of an eye on the differential threshold of the eye. II. M. SOLÍS, M. AGUILAR AND A. PLAZA. *An. Real. Soc. Españ. Fis. Quim.*, **49**(A) 274–80 (*Sept.–Oct.*, 1953) *In Spanish.*

For Pt I, see Abstr. 9255 (1952). Using the same method, a study is made of the influence of the adaptation state of one eye in the differential threshold of the other, for two new levels of luminance in the influenced eye, of higher and lower order to the one already studied. This influence is shown in a magnitude similar to the one obtained for that middle level of luminance. In these cases is also obtained a

minimum for the differential threshold, when the luminances are similar in both eyes. A.

612.843.63

2979. Constancy of the area of stimulus in the determination of the perceptible minimum. M. AGUILAR, M. SOLÍS AND J. YUNTA. *An. Real. Soc. Españ. Fis. Quim.*, **49**(A) 291–5 (*Sept.–Oct.*, 1953) *In Spanish.*

The importance of the stimulus area in the determination of the perceptible minimum is experimentally checked. Low luminances with extra-foveal vision and high luminances with free vision are used. A.

612.846

2980. Frequency and amplitude of ocular tremor. G. C. HIGGINS AND K. F. STULTZ. *J. Opt. Soc. Amer.*, **43**, 1136–40 (*Dec.*, 1953).

Data are presented on the magnitude and frequency of the involuntary eye motions (rapid motions superimposed on slow drifts) that take place during attempted fixation on a target. A record of these motions was obtained by directly photographing a blood vessel of the eye. Vertical and horizontal motions were recorded for both monocular and binocular fixation. The rapid motions were found to have an average frequency of 50 c/s and an average amplitude of 1·2 min of arc. These data are in approximate agreement with previous data of Adler and Fliegelman and of Ratliff and Riggs. Simultaneous tracks of head and eye motions show that the rapid eye motions are independent of head motions. A.

612.846 : 621.397

2981. Eye movements in connexion with television viewing. M. P. LORD. *Nature* [*London*] **172**, 964–5 (*Nov.* 21, 1953).

Movements of one eye were recorded during the binocular viewing of a 9 in. television screen at distances of 34 and 120 cm respectively. The scan was both sequential and interlaced; there was no difference in the type of eye-movements under the two conditions. The instability and "crawling" associated with interlaced scan cannot be expressed in terms of either the amplitude or frequency of the eye-movements. R. A. WEALE

612.85

2982. The dependence of the upper pitch limit on age. F. W. SCHOBER. *Akust. Beihefte, No.* 4, AB 219–AB 224 (1952) *In German.*

A test has been made to determine the upper pitch limit of 590 persons belonging to different age groups and professions. By means of correlation theory the dependence of the upper pitch limit on age was evaluated. Compared with experiments carried out by the physiologist Gildemeister in 1918, hearing sensitivity for high frequencies was found to have decreased, which may be attributed to deterioration of living conditions since then. 80% of the population can hear frequencies over 11 kc/s. Environment influences the hearing sensitivity in different ways. A.

612.85

2983. The form of the threshold of modulation in the auditory area. E. ZWICKER AND W. KAISER. *Akust. Beihefte, No.* 4, AB 239–AB 246 (1952) *In German.*

The threshold of audibility of sinusoidal, periodic loudness and pitch variations of pure tones (thresho of modulation) is determined within the who auditory area at different degrees of modulatio (modulation frequency 4 c/s). Using an audiomet this threshold may be measured by two method The results of both methods agree well. The averag curves from a number of normal hearing observe are shown. They give good information about th hearing ability within the auditory area. Som observed peculiarities, especially of persons wit hearing loss, are described. A

612.8

2984. The size of the basic steps in the perception o pitch and loudness. R. FELDTKELLER AND E. ZWICKER *Acustica*, **3**, 97–100 (1953) [=*Akust. Beih., No.* (1953)] *In German.*

From the measurements of the just perceptibl amplitude- and frequency-modulation of pure tones which E. Zwicker has made with a modulatio frequency of 4 c/s, the size of the basic regions fo the perception of pitch and loudness is computed. A

612.8

2985. The alteration of modulation thresholds by masking tones and noise. E. ZWICKER. *Acustica*, 3 274–8 (1953) [=*Akust. Beih., No.* 2 (1953)] *In German*

Masking by tones and noise tends to raise the threshold of audibility and modulation threshold up to 30 db above the raised threshold of audibility Modulation thresholds in the field of higher sound pressures are not affected at all by masking Thresholds of modulation are very much alike in the case of masking by noise and in the case of impairment of hearing with recruitment. A

612.85 : 534.3

The influence of non-linear distortions on the audibility of frequency vibrato. *See Abstr.* 2163

612.85 : 534.323

The loudness index. *See Abstr.* 2170

612.85 : 534.78

Observation of a further Tartini pitch resulting from a physical sinusoid added to a Tartini pitch. *See Abstr.* 2198

612.85 : 534.862.6

2986. The limits of perceptibility of the amplitude-modulation and the frequency-modulation of a tone. E. ZWICKER. *Akust. Beihefte, No.* 3, AB 125–AB 133 (1952) *In German.*

Measurements have been made of the just perceptible amplitude-modulation and the just perceptible frequency-modulation of pure tones of different pitch and loudness-level as a function of the modulating frequency. Below a certain modulating frequency (the so-called phase-limit-frequency) the ear is able to distinguish between the two kinds of modulation and perceives the amplitude-modulation much better. Above this phase-limit-frequency there is no perceptible difference between frequency-modulation and amplitude-modulation. The phase-limit-frequency has a value of about 30 c/s for low-frequency tones and rises to 1 kc/s for tones with a frequency of about 10 kc/s. The influence of the frequency response of the transmission-system upon the perceptibility of frequency-modulation has been investigated and a certain slope of the frequency response is given

which converts a just perceptible frequency-modulation into a just perceptible amplitude-modulation. This permissible slope amounts to about 0·15 db/(c/s) for audio-frequencies up to 1 kc/s and then decreases down to 0·01 db/(c/s) for a frequency of 10 kc/s. A.

612.85 : 534.862.6

2987. On the audibility of non-sinusoidal variations of pitch. E. ZWICKER. *Funk u. Ton*, **7**, 342–6 (*July*, 1953) *In German*.

In an earlier paper (preceding abstract) the author described an investigation on the sensitivity of the human ear to sinusoidal frequency modulations of 4 c/s modulation frequency. In the present investigation measurements are described in which the modulation is non-sinusoidal. Three cases are examined: (1) a short triangular pulse, (2) a short rectangular pulse and (3) a short half-cycle cosine pulse, repeated at 4 c/s. The effect of increasing the modulation frequency from 4 to 20 c/s is also examined.

A. B. WOOD

612.85 : 534.862.6

2988. The perception of amplitude modulations. H. EBEL. *Akust. Beihefte*, *No.* 4, AB 246–AB 250 (1952) *In German*.

In accordance with results of Zwicker it has been found that amplitude modulations with high modulation frequencies can be perceived with smaller modulation factors than amplitude modulations with low modulation frequencies. This phenomenon can be explained by masking of the combination tones produced. Such a modulation is less perceptible with speech and music than with pure tones. Speech especially is not very much disturbed by amplitude modulations. The results of this work indicate how small the modulation factor (identical with the distortion factor) of a loudspeaker system should be, so as not to be disagreeable. A.

612.85 : 534.862.6

The perceptivity of non-linear distortion in the transmission of two-note chords. *See Abstr.* 2221

612.858

2989. The cochlea effect during the closing of the round window. O. F. RANKE, W. D. KEIDEL AND H. G. WESCHKE. *Akust. Beihefte*, *No.* 3, AB 145–AB 148 (1952) *In German*.

The round windows were closed, in the ears of four cats, by means of rubber pistons covered with plastillin and thin rubber foils. Before, during and after the piston was applied microphonics were measured with and without superposed action-current. When the round window is closed microphonics decrease and the action-current disappears. Immediately after the piston is removed the original form of potential and the same amount of action-current reappear. From this it is concluded that the amount of microphonics is determined not by the pressure in the inner ear but by the displacement of the basilar membrane. A.

612.858 : 534.79

2990. Acoustic trauma in the guinea pig. H. DAVIS AND OTHERS. *J. Acoust. Soc. Amer.*, **25**, 1180–9 (*Nov.*, 1953).

The ears of anesthetized guinea pigs were exposed to intense tones of 185, 545, 2000 or 8000 c/s at sound pressures (at the eardrum) from 138 to 148 db re 0·0002 microbar. The electrical output was recorded by differential intracochlear electrodes before, during and after the exposures. The injury caused by 8000 c/s centres in the basal turn, by 2000 c/s in the second turn, by 500 and 185 c/s in the third and fourth turns of the cochlea. No single tone, at the intensities and durations employed, injured all of the cochlea. The "threshold" and also the maximum voltage of the cochlear microphonic are valid indices of the anatomical injury seen under the microscope if the proper test frequencies and positions of electrodes are used. The destructiveness of a tone does not depend on its frequency. Equally severe (probably permanent) injuries were produced by a one-minute exposure at all four frequencies tested when the intensity level was about 144 db at the eardrum. A.

612.858.751

2991. Spatial hearing. H. KIETZ. *Acustica*, **3**, *No.* **2**, 73–86 (1953) *In German*.

Every person of normal hearing associates with each sound perception a sense of direction as well as of distance from the source. To explain this effect it is necessary to consider the problem under the following aspects: "Left—right" perception; "In front—behind" perception; "Above—below" perception; "Near—far" perception; Pure tones, noises, short impulses; Physical—physiological effects. The "left—right" perception is to be traced to time and intensity differences in the excitation of the two ears which both act in the same sense and support each other. It is possible to show how with pure tones these two effects, i.e. time and intensity differences, operate. Damped tones, short pulses and noises give a sharper and better distinguished direction perception than sustained tones. The author's results show that in perceiving "in front—behind" and "above—below" the sound spectra which are set up in the eardrum are important. These are not exact copies of the spectra of the sounds as they are received at the head because the latter with its sound-shadows and the ear muscles distort the sound in a quite characteristic way, depending on the direction of arrival of the sound rays. Our subconsciousness has, from long experience, the faculty to interpret these distortions into perceptions of sound direction in space. Turning the head and the resulting change in relative direction perception helps and increases the perception of direction. For the perception of "near—far" the opinion of v. Békésy is supported, i.e. that the spectrum apprehended in our subconsciousness gives the appreciation of distance. A.

614.898 : 539.16.08

2992. Radiac instrumentation. D. TAYLOR. Letter in *J. sci. Instrum.*, **30**, 436 (*Nov.*, 1953).

Supplements the paper by this author [Abstr. 9269 (1952)] by indicating the rate at which flash dosemeters would be irradiated by an atomic bomb explosion. Saturation for dose rates of 200 r/sec is required. 200 r of γ-rays should not cause more than 20%/hr natural leakage in the insulators, one hour after irradiation. Polystyrene and Kel-F are satisfactory. D. V. MABBS

PHOTOGRAPHY 77

771.5 : 539.27

The electron microscopy of photographic grains. Specimen preparation techniques and applications. *See Abstr.* 2786

771.53 : 539.166.08

2993. Determination of the γ-ray sensitivity curve of photographic emulsions. L. ARGIERO. *Nuovo Cimento*, **10**, 1035–9 (*Aug.*, 1953) *In Italian.*

Fourteen types of "Ferrania" photographic emulsion were measured, with their relative error. For every type the range of sensitivity to be used for protective dosimetry for scientific, biological and industrial purposes was determined. A.

771.534

2994. Factors that determine the form of the characteristic curve of an emulsion as a function of the light of exposure. M. T. VIGÓN AND M. A. DE LA VEGA. *An. Real Soc. Españ. Fis. Quim.*, **48**(A) 193–200 (*July–Aug.*, 1952) *In Spanish.*

Examination of the causes that originate variation of the form of the characteristic curve of a photographic emulsion when the spectral composition of the light of exposure is modified, shows that the three following are fundamental: absorption of light by emulsion, absorption of light by grains of silver halides, and distribution of the latent image in the surface and the interior of the grain. The following empirical relation was established experimentally: $\gamma_s + \gamma_i = K(1 - c)^P/(1 - a)^P$. The value of this relation is to be taken as approximate. Its application to two cases studied by other investigators was tested. A.

771.534

2995. Factors that determine the form of the characteristic curve of an emulsion as a function of the spectral composition of the light of exposure. II. New experimental verification. M. T. VIGÓN AND A. S. BRETÓN. *An. Real Soc. Españ. Fis. Quim.*, **49**(A) 55–62 (*Jan.–Feb.*, 1953) *In Spanish.*

Using a spectrograph the characteristic curves formed by light of different wavelengths on the same emulsion were determined, and it is proved that the results obtained correspond to the equation established (preceding abstract) though the values of K and p differ from those previously found for the same emulsion. The possible causes of these discrepancies are analysed and the conclusion is reached that the value of K depends essentially on the developing conditions and is affected by the errors in the methods used for obtaining the characteristic curves. The value of p is a function of the exposure time and the errors in the way of expressing the factors of light absorption by the emulsion and by the grains of silver halide affect it profoundly. A.

771.534 : 535.34

2996. The long-wavelength edge of photographic sensitivity and of the electronic absorption of solids. F. URBACH. Letter in *Phys. Rev.*, **92**, 1324 (*Dec.* 1, 1953).

For an unsensitized AgBr emulsion the plot of log of sensitivity v. frequency ν approaches a straight line of slope $1/kT$ as ν decreases into the region of low sensitivity (at ~ 5000 Å). Similarly, measurement of the absorption coeff. ε of AgBr crystals in the region of the absorption edge shows that $d \log \varepsilon/d\nu \simeq -1/kT$ between 200° and 620°K when $\varepsilon < 1$ cm^{-1}. S. T. HENDERSON

771.534.5 : 535.247

An automatic recording photographic densitometer. *See Abstr.* 2227

771.535 : 539.27

2997. Electron microscopical studies of the latent image obtained by exposures to alpha particles, X-rays and light. H. HOERLIN AND F. A. HAMM. *J. appl. Phys.*, **24**, 1514–19 (*Dec.*, 1953).

The latent image of ordinary photographic emulsions has not been resolved. However, the slightly enlarged latent image as obtained by physical gold development can be demonstrated by means of the electron microscope. For the case of a fast negative emulsion it is shown that different types of exposures result in latent image centres of significantly different size distribution characteristics. High-intensity α-particle and X-ray exposures produce a very large number of finely dispersed centres; irradiation with light of optimum intensity and 1/100 sec duration forms a small number of centres; only very few specks result from exposures to light of very low intensity. The patterns observed are in line with expectations based on current photographic theory. A.

778.3 : 535.41

Use of high contrast in the photography of interference fringes. *See Abstr.* 2334

778.33

2998. Fluoroscope image amplifying tube. F.-H. MARSHALL. *Electronics*, **26**, 172–3 (*Oct.*, 1953).

This tube provides a 200-fold increase in brightness of shadowgraph images obtained in X-ray medical examinations. The X-rays pass through the patient and the glass envelope of the tube to strike an input fluorescent screen. The resulting light on the screen releases photo-electrons from a photo-surface on the back and these electrons are accelerated by means of a 30 kV lens and made to converge on to a second fluorescent screen with a magnification of 1/4·5. The image is brought back to size by means of an optical lens. The voltage acceleration gives a brightness amplification of ×10 and the image reduction ×20, a factor which is not lost by the subsequent optical magnification. The electron lens consists of a series of short cylinders of increasing potential placed one behind another between the screens with 1/8 in. spacing. The choice of the optimum phosphor for obtaining high efficiency and for absence of excess persistence is studied. For the photo-surface CsSb is preferred because of its high threshold energy of escape at room temperature. H. G. M. SPRATT

778.33 : 537.531 : 535.42

2999. Microradiography and micro X-ray diffraction. A. ENGSTRÖM. *Trans Instrum. Meas. Conf.* **1952**, 88–92.

A survey, including details of various micro-

radiographic methods (including X-ray shadow microscopy) and genuine X-ray reflection microscopy. Stereoscopic microradiography is also discussed and a final section is devoted to micro X-ray diffraction.

J. THEWLIS

778.33 : 537.533

3000. Some experimental findings and operating practices in betatron radiography. N. C. MILLER AND J. D. STEELY. *Nondestr. Test.*, **11**, 35–40 (*Nov.–Dec.*, 1953).

The 3½-year history of a 22 MeV fixed beam betatron installation is summarized. Periodic maintenance procedures are outlined and time losses due to breakdown are tabulated; practical methods of beam alignment and focal spot correction are described. Typical applications are illustrated and discussed, such as radiography of thick steel sections and other common materials, use of the high subject latitude inherent in the 22 MeV radiation, direct magnification during radiography and methods of stereoradiography. Some of the experiments which have been performed are described briefly; they concern the use of shaped compensators to obtain uniform beam intensity distribution within a prescribed angle, the usefulness of a vacuum type cassette, a comparison between radiographic and photographic enlargement and optimum intensifying screen thicknesses under various conditions. Lead screen combinations ranging from 0·010 in. to 0·120 in. front and 0 to 0·040 in. back are evaluated. A.

778.33 : 539.166

3001. Effects of source and specimen dimensions on resolution in gamma radiography. A. J. STEVENS. *Nondestr. Test.*, **11**, 13–15 (*Nov.–Dec.*, 1953).

A general quadratic equation is developed which expresses the dispersion to be expected from a γ-source in terms of the geometry of the exposure set-up. Of the various sized rods of cobalt 60 available from Oak Ridge National Laboratory, the $\frac{1}{8}$ in. rod is most useful for industrial radiography. The optimum practical length of such a cobalt 60 source is approximately $\frac{1}{2}$ to $\frac{5}{8}$ in. A curve is given which relates specimen dimensions to source-film distance for a "standard" source. A.

778.34

3002. The grain density and the process of track formation in nuclear emulsions. II. Grain density and energy loss. M. DELLA CORTE, M. RAMAT AND L. RONCHI, JR. *Nuovo Cimento*, **10**, 958–70 (*July*, 1953).

The method described in Pt I [Abstr. 8167 (1953)] for the evaluation of π (the probability that a grain be impressioned) was applied to ~50 tracks, observed in Ilford G5 plates and belonging to identifiable particles of a given range. Experimental data have been plotted versus energy loss and compared with the expression given by P. Demers [Abstr. 396 (1948)]. It is recognized that some modification of the theory is required to account for the results. In fact, it is shown that the discrepancies can be made to disappear if the effect of the electron recombination inside the grain is suitably taken into account. A.

778.34 : 537.534.75

3003. Ionization loss at relativistic velocities in nuclear emulsion. B. STILLER AND M. M. SHAPIRO. *Phys. Rev.*, **92**, 735–41 (*Nov.* 1, 1953).

The variation of grain density in the tracks of singly-charged relativistic particles traversing a nuclear emulsion has been investigated as a function of velocity in Ilford G5 plates exposed to the cosmic radiation at 100 000 ft. Multiple scattering measurements and "blob counts" were made on long tracks of electrons, mesons and protons with energies γ up to 3400 rest mass units. The blob density G_{pl} at the Fermi plateau of ionization was found to be $1{\cdot}14 \pm 0{\cdot}03$ times G_{min}, in agreement with the result previously obtained by another method. Protons and electrons show the same value of G_{pl}. The data are compared with the theories of Halpern–Hall and of Sternheimer for AgBr, using the ionization potentials of Bakker and Segrè. Since only grains along the track were counted, the calculated energy loss is restricted to energy transfers less than an upper limit T_0. Calculations for two assumed values of T_0, 2 keV and 5 keV, fit the data equally well, yielding ratios G_{pl}/G_{min} of 1·15 and 1·14 respectively. The data are also consistent with the slow rate of rise from minimum ($\gamma \sim 4$) to plateau ($\gamma > 100$), which is predicted by the theory. A.

778.34

3004. Tracks at minimum ionization recorded in a fine-grain laboratory-made emulsion. P. DEMERS. *C.R. Acad. Sci.* [*Paris*] **237**, 1228–30 (*Nov.* 16, 1953) *In French.*

A brief description is given of the method of preparing a nuclear emulsion having a mean grain diameter of 0·08 μ and which will record particles of minimum ionizing power as tracks with grain densities of 13–20 grains per 100 μ. A. C. COATES

778.34

3005. Recovery of isotopic boron and lithium from nuclear research emulsions. M. L. SMITH. Letter in *Nature* [*London*] **172**, 1054 (*Dec.* 5, 1953).

Approximately 90% of the boron and 67% of the lithium used in loading nuclear emulsions can be extracted by presoaking the emulsion for one hour in distilled water before development. The remainder can be recovered from the developer solution.

A. C. COATES

778.34 : 539.16

3006. The dissociation and diffusion of rare gases from radioactive stars in nuclear emulsions. L. VIGNERON, R. CHASTEL AND J. GENIN. *J. Phys. Radium*, **14**, 28 S–29 S (*Oct.*, 1953) *In French.*

A greater number of isolated α-particle tracks and fewer "stars" with four branches were observed in the radioactive decay series of radium than the corresponding number predicted theoretically. This discrepancy is due to some of the radon diffusing out of the emulsion before decaying into radium A. Not all the radon is free to diffuse; it is assumed that four branch "stars" arise when radon is trapped in the lattice of a silver halide crystal. Additional evidence for the existence of trapped radon is briefly described [see also Abstr. 8165 (1953)]. For the radioactive decay series of thorium X, a similar diffusion of thoron is observed, but in this case the half-life of thoron is so short that it cannot diffuse out of the emulsion. The free thoron produces a three-branch

"star" a short distance from a single α-particle track due to the decay of thorium X into thoron.

A. C. COATES

778.34 : 539.163

New method for the study of radioactive phenomena: ciné-nucleography. *See Abstr.* 2693

778.37 : 621.389

3007. Simple electronic devices for high-speed photography and cinematography. P. FAYOLLE AND P. NASLIN. *J. Soc. Motion Picture Televis. Engrs*, **60**, 603–26 (*May*, 1953).

Early experiments are mentioned and the modern electronic methods permitting greater accuracy, reliability and flexibility are described. Shadowgraphic pictures of events taking 10^{-7} sec or less are obtained by a condenser discharge through a pin-point spark-gap. Other light sources employing gas-filled tubes for schlieren photography and very heavy discharges up to 200 J at 22 kV are used in the "Defatron" guided spark equipment for reflected light exposures. Another method uses the Kerr-cell effect operated by a 22 kV rectangular pulse as short as 0·1 μsec. If the subject is not self-luminous the Kerr-cell shutter is synchronized with a guided spark light-source. The spark systems may be extended so as to use several discharges in succession. A flash generator designed for use with the Cranz–Schardin set-up yields 30 frames up to 10^6 f.p.s. By another method and using a rotating mirror scanning a film on a fixed drum, 200 images at 50 000 f.p.s. can be obtained. Circuit diagrams and photographs of all this equipment are given. B. B. AUSTIN (R)

778.6

3008. Principles of color photography. R. M. EVANS, W. T. HANSON, JR AND W. L. BREWER. *New York: John Wiley*, 709 + xi *pp.* (1953).

Review in *J. Opt. Soc. Amer.*, **43**, 930 (*Oct.*, 1953). "A basic and fundamental treatise, being a development of some 15 years' effort to bring together the technical concepts of colour photography."